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THE SPECIFICATION OF DOSAGE IN RADIUM THERAPY

JANEWAY LECTURE, 1940*

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NEW YORK, NEW YORK

I AM DEEPLY appreciative of the honor which comes to me in the invitation to deliver the Janeway Lecture this year. My personal association with Dr. Janeway extended over only a few years, and this at a time when his activity was limited. But from the beginning of my appointment at the Memorial Hospital, I found all the work in radiation therapy imbued with his spirit of scientific investigation. It is due to his leadership that such close cooperation has always existed between the clinical and the research departments of the Hospital. He was particularly interested in the department of physics from its inception, and much of the early research work of that department was stimulated by his desire to improve methods of radium application.

It seems fitting, therefore, that I should discuss at this time the working out of a problem with which he was continually occupied, and on which more has probably been done in the laboratories and clinics he first sponsored than in any other one place, namely the expression of dosage in radium therapy.

Dr. Ewing, in the first Janeway lecture, brings out this point.[8] He says: "The early workers had to rely chiefly upon clinical observation, trial and error, in determining the comparative effects of different filters, distances, and times of application. Yet it was obvious that methods could not be standardized or results repeated unless the amount of energy actually reaching the tumor was calculated by physical measurements or estimated by repeated experiments. In conjunction with his laboratory colleagues Janeway devoted much time and thought in formulating the problems and assisting in their solution."

The fact has been stated often in recent years that any biological change brought about by irradiation must result from a transfer of energy from the radiation to the affected cells. This seems to us now almost self-evident, yet in the early days of radium therapy it was not recognized as a basic principle. Even after it was so recognized, it was widely ignored. Radium "dose" was almost universally stated in terms of the amount of radioactive material employed and the duration of the irradiation. Since a unit quantity of radium or radon in equilibrium with its products always emits the same amount of energy in unit time, the

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specification of milligram- or millicurie-hours, together with the filter employed and the size and shape of the applicator, contains implicitly a definite statement of the energy leaving the source, which may be called the *emitted dose*. But the quantity of radiation arriving at the cells to be affected, the *dose delivered*, may be an extremely small percentage of the energy emitted, and the actual *dose absorbed* a still smaller percentage.

Some twenty years ago, these inconsistencies in dosage specification began to receive criticism. In 1919, Regaud commenced an article by calling attention to the differences between the dose emitted and the dose received,—but he continued to specify his own doses in terms of the former.[57] Two years later, before the Sixth Annual Meeting of this Society, Failla analyzed the problem in some detail.[10] He pointed out both the desirability and the difficulty of expressing the dose actually absorbed in the tissues, in terms of energy units, such as ergs or calories, and made some approximate calculations of the dose, thus expressed, which would produce a mild skin reaction. He also called attention to the possibility of the use of *biological* units of dosage.

Experimental attempts to establish units for radium dosage were begun about this time, and have been carried on ever since, in many institutions and by a wide variety of methods. At the Memorial Hospital the problem has been studied in the departments of biology, biophysics, chemistry, pathology, and physics, as well as in the clinical services. Cooperation among workers in different fields, so essential in such work, has existed in the highest degree. During the past twenty years, more than fifty papers bearing directly on the question of radium dosage have been published by members of the laboratory and clinical staffs of the institution. The literature during this period contains hundreds of contributions from investigators in many countries.

This extensive study attests the importance of the problem, and also its complications. The question of proper measurement and expression of radium dosage is much more difficult than the corresponding one for roentgen rays, for various reasons, of which possibly the most important are the small amounts of radioactive material available for most experiments, and the extremely penetrating nature of both the gamma rays and the secondary beta rays. Additional difficulties arise from the fact that, while in the case of roentgen rays the source of radiation is usually at a considerable distance, relatively speaking, from the diseased region undergoing treatment, with radium the source is very close to these tissues, or even actually embedded within them. Ionization measurements, which early proved very useful in measuring roentgen-ray intensities, are almost useless under these methods of application. In an ionization chamber only 1 cm. in diameter, so placed that its center is 1 cm. from a small radium source, the intensity of radiation in the portion of the chamber nearest the radium is approximately nine times as great as that in the opposite portion, so that the actual ionization recorded means little. Yet in interstitial therapy, it is dosage at just such short distances that is important.

Because of these difficulties with direct physical measurement, several other approaches to the problem have been used, as already suggested. Various biological reactions have been considered for the determination of a unit dose. The first of these was probably that offered by Russ,[58] who proposed as a unit the amount of radiation necessary to kill mouse cancer, the amount to be determined experimentally and called the "rad." Ghilarducci[21] suggested the amount necessary to produce ulceration of the intestines of rats. Others have made use of killing effects on small biological organisms, such as *Ascaris* or *Drosophila* eggs, notably Zuppinger,[69] Braun,[1] Henshaw and Francis,[25] and Exner and Packard.[9] Of special practical value have been studies based on the erythema

reaction produced in human skin. These will be discussed in some detail later.

It should be noted that any such biological dose, if it can be determined with sufficient accuracy, can be established as a *standard*. However, it cannot be used directly as a *measure* of the amount of radiation administered. That is, the application of twice as much radiation will not result in twice as many killed eggs, or twice as red an erythema. In order to make practical use of such a unit, it is necessary to have a calibration curve for variation in effect with variation in dose. Since the dose varies with change in any of the physical factors involved—quantity of radium, filter, distance, shape of applicator, and duration of irradiation, the effect of each such alteration in relation to the standard reaction must be determined. Obviously either an indefinitely large number of combinations of physical factors must be tested experimentally and calibration curves developed, or else rules must be worked out for the effects of possible changes.

The experimental method is readily applicable to such a reaction as *Drosophila* egg killing; it is more difficult in the case of effects in more complicated organisms. The necessary calibration curves can be developed only on a basis of statistical studies on many individuals; hence, unless many can be irradiated at once, the necessary experiments are burdensome. In such a case it is preferable to calculate, so far as possible, what the relationships should be, and then check the conclusions experimentally.

The problem would be greatly simplified if a chemical or physical standard reaction could be employed, in which the effect produced would be proportional to the amount of radiation delivered, or absorbed. As has been pointed out, the size of the ionization chamber limits its usefulness; the same is true of even small containers for chemicals which undergo transformations under the action of the rays. In this regard, photographic methods appear to offer advantages of convenience and simplicity. Such procedures have been employed by a number of investigators, among them Mazérès,[41] den Hoed and Stoel,[4] and especially Holthusen[26] and his associates. Within considerable limits, the opacity of the film is proportional to the amount of radiation falling on it, so long as the quality of the radiation, the nature of the film, and the details of development are unchanged. Variations in opacity of film resulting from a single exposure can be studied almost from point to point. Pieces of film can conveniently be placed within blocks of material serving as "phantoms" to investigate dosage within the body. In any single experiment, pieces of the same film can be employed, and all developed together, so that these two factors are constant. However, because of the presence of a heavy metal (silver) in the photographic emulsion, the slight changes in the quality from point to point within the phantom, due to differences in scattered radiation, and particularly in secondary beta rays, render the method of limited value. It is possible to standardize films for any given quality of radiation, but the range of qualities within the phantom cannot be determined at the present time.

The most direct measurement of the energy absorbed by the tissues in any given case would be the determination of the amount of heat generated by this absorption in the region under consideration. The use of the erg as a dosage unit appeals to the physicist, and was early suggested by Failla[10] (1921), Dauvillier[3] (1923), and others. Failla calculated the approximate number of ergs (or calories) required to produce an erythema. More recently, Lauritsen[30,31,32] has devoted considerable attention to the theoretical aspects of this subject.

The earliest experimental attempts to measure the heat resulting from the absorption of radioactive radiations were those of Rutherford and Robinson[60] in 1913; these have been followed by many others. The most accurate results have probably been obtained by Ellis and Wooster,[5] and by Zlotowski.[68] These, however, refer to the

heat generated in the total absorption of the radiations from the radioactive material, and not to the portion absorbed in a small region.

The direct measurement of heat generated in a small volume of organic material, under conditions analogous to those of therapy, is extremely difficult. Stahel[65] devised a very ingenious calorimeter which enabled him to determine the energy absorbed from gamma rays in a known (but not very small) volume of petroleum ether with the radium source at its center. By means of this apparatus and certain subsidiary measurements, he was able to express in ergs the amount of radiation absorbed within definite volumes of tissue in certain types of treatment. His values for the amount of energy necessary to produce a given reaction are considerably higher than any of the calculated ones, which are based on careful calorimetric experiments of other physicists. His method is complicated and requires considerable technical skill; it is not practicable for the general radiation therapist, and has, in fact, had little acceptance outside Stahel's own institution.

Since this direct approach to a determination of the absorbed energy is so difficult, the development of other methods is important. As early as 1906, Eve [6,7] suggested an indirect approach to the same problem, namely, the determination of the number of ion pairs produced during the absorption of the radiation, and of the energy absorbed per ion pair. He was interested in the measurement of the *total* energy rather than that absorbed in a small volume, but a modification of his method could be applied to the dosage problem. The determination of the total number of ion pairs depends on the measurement of ionization in a definite volume of air, at a definite distance from the source, and a calculation from this result of the ionization throughout space. Eve carried out experiments along this line over a period of years, as did Moseley and Robinson,[43] Gray,[23] and others. The lack of agreement among their results as to the total ionization indicates the difficulty of the problem. Further, the values found by various physicists for the amount of energy required to form an ion pair differ considerably among themselves.

In any case, from the point of view of dosage specification, as has been stated, it is not a knowledge of the total energy emitted from a radioactive source which is the information desired, but a knowledge of the energy absorbed within a specified region in the human body. In order to obtain this, the number of ions produced *in this region* must be known, together with the energy required to produce an ion pair within the substance of the tissue.

For roentgen rays, in the 100–200 kv. range, a unit which offered a reasonable approximation to this sort of dosage measurement was developed during the years between 1920 and 1928, by the cooperation of radiologists and physicists throughout the world, and finally adopted by the Second International Congress of Radiology, in Stockholm in 1928, as the *roentgen*.[61] The wording of the definition of the roentgen has been altered somewhat since its adoption, but it is, essentially, the amount of roentgen radiation which, under proper conditions, produces, by the complete absorption of its secondary corpuscular rays, a certain specified number of ion pairs (2.41×10^{15}) per gram of dry air. For roentgen rays such as are ordinarily employed in therapy, it is possible to realize the desired physical conditions by means of small ionization chambers which can be placed at the point where the measurement is to be made. Roentgen-ray doses within the body (or within a phantom) are then determined in terms of the ionization produced in a small volume of air at the point in question. Just how much this differs from the ionization produced in an equal mass of tissue is yet to be determined. It can be estimated fairly closely, however.[24]

From the time of its adoption the roentgen proved to be a very useful unit for the measurement and specification of roentgen-ray dosage; it naturally appeared desirable

to extend its application to the measurement and specification of gamma-ray dosage. However, as has been suggested earlier, experimental difficulties in the way of realizing the proper conditions are much greater for gamma rays than for 200 kv. roentgen rays. During the past ten years, a great deal of work has been done, both in Europe and America, in the endeavor to overcome these difficulties and arrive at a really suitable method of measurement.

Meantime, from the practical point of view, it has been necessary to develop a workable dosage system for gamma rays. In the absence of acceptable physical methods, it was to be expected that such a system should have a biological basis. Indeed the opinion has often been expressed that, since the therapeutic effect of radiation is biological, such a unit is more rational than a physical one. Experimental work in the direction of establishing a practical system has been carried on simultaneously with that just mentioned on accurate physical measurements, often in the same laboratories, but along very different lines. Useful methods have been developed and employed—always with the reservation that when something more accurate, or otherwise more desirable, should appear, it would be welcome. To the end that doses expressed in practical units might at any subsequent time be re-stated in terms of something more exact, radiologists have been urged to keep as complete records as possible of all physical factors, in addition to the estimated dose.

At the present time, it appears that an ionization unit can be established. Much of the work already done from the practical side would have been necessary in any case, however. Now from the correlation of both lines of investigation, a satisfactory dosage system should be developed.

In the remainder of my time, I propose to follow briefly these two series of investigations, and finally to indicate their combination.

There are, of course, two aspects of the dosage problem, depending on whether the sources are external or interstitial. To a certain extent, these overlap, for instance dosage with tubes close to the skin, in a moulage, or in an intracavitary applicator, cannot be very different from that with implanted needles, under proper methods of comparison. At first treatments in all types of radium therapy were empirical; radiologists administering them learned from experience and observation just about how much the skin would tolerate from a given applicator, or how many seeds or needles it was safe to insert into masses of various sizes and shapes, in different locations. Little or no correlation was possible between dosages in treatments with different sources.

Before any attempt was made to establish a dosage unit, this question of comparison of radiation from different sources was investigated. It was known that a given amount of radium distributed within an applicator of large area does not produce the same reaction, for a given time of irradiation, as when it is concentrated in a tube or small applicator at the same distance. This is inevitable, since in the first case the distance from part of the radium to any point on the skin under the applicator is considerably greater than in the second case. Further, the rays from these more distant points travel more obliquely through the material of the applicator, and are hence reduced in intensity by extra filtration.

For the comparison of intensity of radiation from specific applicators at definite distances, various methods are available. The first direct experimental work appears to have been that of Friedrich and Glasser,[19] in which, by means of a small ionization chamber, they actually mapped surfaces of equal intensity around radium capsules of various lengths, coining the word "isodose" line or surface to express these. Others followed this method and obtained additional data, with ionization chambers as small as they could construct (Mallet,[37] Kessler and Sluys[28]). That of Stahel,[64] only 2 cubic millimeters in volume, and filled with petroleum ether, deserves special mention.

Because of the handicap of the size of

even very small ionization chambers, efforts were made to map isodose curves photographically and by means of such biological experiments as the killing of *Ascaris* eggs, but for various reasons none of these yielded much useful quantitative information.

In any event, the general problem of making possible the comparison of radiation from applicators of many shapes and sizes, at various distances, cannot well be worked out experimentally. The preparation of the many necessary sources and the making of the minimum requisite number of measurements on each is impracticable. The much more desirable procedure is to develop a general method of calculating the relative intensities, and then to test experimentally a few of the results thus obtained.

A very detailed study of this sort was made at the Memorial Hospital in 1922. In the published paper[48] were given the *relative* amounts of radiation delivered at the center of the skin field under the applicator, by a constant amount of radium (or radon) distributed uniformly in tubes of various lengths, and in circular, square, and rectangular applicators of various areas, for several filtrations and for any distance from 1 to 10 cm. The method employed was to divide each source into a considerable number of small parts, each of which could be considered as approximately a point source, and to calculate the distance of each of these from the chosen location on the skin. The effect of the additional filter for each point source was also determined, on the basis of experimental absorption curves for the various metals considered. The sum of the contributions of the separate elements gave the total dose, in arbitrary units. For convenience, the doses delivered by all applicators were related to the dose from a point source. The tables contain data for some 200 practical applicator sizes and distances; information for any one not actually included can be obtained by interpolation.

If, now, the number of milligram- or millicurie-hours required to produce any specified reaction with any one of the listed applicators is known, that for any other can be determined. Further, doses can be expressed in fractions or multiples of the amount necessary to produce this standard reaction.

The standard usually chosen is some form of skin erythema. As a check on the practical application of the calculated data, and as a means for establishing a clinical dosage unit, the exposures (in terms of milligram- or millicurie-hours) which should produce a faint erythema with all the various radium and radon applicators then in use at the Memorial Hospital were calculated on the basis of the experimentally determined erythema dose for a single tube at a distance of 2 cm. The clinical radiologists were then asked for their observed erythema doses. Since at that time most treatments were given at single exposures rather than in divided doses, there was a mass of clinical information available. In each case, the dose specified by the radiologist for a given applicator agreed with the one calculated by the physicist, within the limits of observation.

On the basis of this work, therefore, it became possible for radiologists anywhere to compare doses delivered on the skin by various applicators, and to express these in terms of the erythema dose.

More recently, Sievert,[62] Mayneord,[39] and Paterson and Parker[46] have published calculations for the distribution of radiation about various radioactive sources, employing more precise mathematical methods, but covering smaller ranges of practical applicators. All of these values calculated by different physicists are in satisfactory agreement.

The tables mentioned above can be applied to any tubular or flat sources and, either in their original form or with some modifications, have been in quite general use ever since their publication. They are not strictly applicable, however, to irregularly shaped applicators, such as moulages, or to curved surfaces. Each case of this sort constitutes an individual problem.

Murdoch, Simon and Stahel[44] have developed a method for dosage expression in treatments of this type, and have used it extensively. The calculations required for each individual applicator are rather laborious, and the method has never been widely adopted. Paterson and Parker[46] introduced a method of approximating dosage from concave and convex applicators which is probably somewhat less accurate, but much more practical for the average radiologist.

Thus far, consideration has been devoted mainly to external applicators. In interstitial irradiation, both the size of the sources and the distances to be considered become very much smaller than in external irradiation. For "seeds" and small needles, and distances of a few millimeters, even the smallest ionization chambers available become too large for accurate measurement. In the case of longer tubes or needles, at distances of more than about 2 cm., isodose curves previously referred to (Glasser, Sievert) are applicable. However, they are not satisfactory for points close to the source, which are of principal interest in this type of treatment.

The first systematic experimental attack on the interstitial dosage problem was conducted by Failla, with the cooperation of a number of members of the laboratory and clinical staffs of Memorial Hospital.[11,13] Studies were first made of unfiltered glass radon seeds, and later, of filtered gold seeds and small platinum needles. It should be noted that in experiments with radon lasting more than a few hours, its radioactive decay must be taken into consideration. With radium the decay is so slow that this necessity does not arise. However, when due allowance is made for this decay, experimental data obtained with radon are applicable to radium (or vice versa) if the containers are alike. Such allowance can usually be made in physical or chemical experiments; it is often difficult in biological or clinical ones, because of the recovery from radiation effect which goes on in living tissue. In order to be certain which of the experimental data were applicable to radium, in cases where most of the work was done with radon, subsidiary experiments with radium were carried out.

The fundamental information sought was the manner in which the intensity of radiation decreases in tissue with increasing distance from the tiny sources. This depends, of course, on the geometrical relations (inverse square law as modified by length of source) and on absorption and scattering of radiation by the tissue. Three experimental methods of approach to this problem were employed, which may be briefly described. The relation of milligram- or millicurie-hours exposure to the radius of the necrotic region produced around the source was determined when seeds or needles were implanted in the dorsal muscles of rabbits. The animals were sacrificed at various periods after the implantations, and the affected regions carefully dissected out and measured. A curve was plotted giving the relative amounts of radiation required to produce necrosis at various distances, in terms of the amount required to produce the reaction at a distance of 3 mm. A second and similar curve was obtained for the amounts of radiation required to bleach butter, when the sources were embedded in it. A third was developed for the production of erythema in the human skin. In this case, the direct experiment, of implanting seeds under the skin and observing the reaction, is obviously impracticable. However, they can be placed at known depths in blocks of beeswax (which has essentially the same absorption and scattering effects on gamma rays as does normal muscle tissue) and placed above the skin. The dose required to produce the erythema with the radium at any particular distance in the wax above the skin can be considered as approximately the same as would be required if it were at the same distance in the tissues below the skin. The three curves thus obtained extend from the surface of the implant out to various distances. The first, for rabbit muscle, was the most limited; it was found difficult to obtain satisfactory measurements for necrotic volumes much more

than 1 cm. in diameter. With larger volumes, the situation was almost invariably complicated by infection. The erythema experiments could readily be carried to a distance of 2 cm., and the butter even farther. At this distance, and beyond, ionization measurements, if made under proper conditions, are useful.

All the experimental curves are in essential agreement as to the *percentage* variation in intensity of radiation with distance from the source. By combining them, it is possible to construct an *average* curve from which can be read the variation in intensity of radiation with distance from radium or radon sources of the dimensions and filters used in the experiments.

A similar curve can be calculated, in the same manner as has already been described for external sources, due allowance being made for the absorption of the radiation by the tissue. Such calculations, for interstitial sources, have been made by Sievert,[62] Paterson and Parker,[46] Laurence,[29] Quimby,[49] and others; their results are all consistent. In the range in which these calculated curves overlap the average experimental one, the values agree. It is apparent, therefore, that, for distances, dimensions, or filters, which have not been tested experimentally, but which are not very different from those which have, it is satisfactory to calculate values. From such a curve, experimental or theoretical, it is possible to determine the *relative* doses at various positions in tissue. If the *absolute* dose were known, in terms of any satisfactory unit, for any one position, or distance from the tube, it could then be determined for all others.

While these investigations regarding the distribution of radiation around radium or radon tubes buried in tissue were going on, clinical radiologists who employed interstitial sources, particularly seeds, repeatedly pointed out the need for a practical dosage system. At that time, doses for roentgen ray and external gamma-ray treatments were generally expressed in terms of some form of erythema dose, the roentgen having not yet been established as a dosage unit. It seemed desirable to express doses in interstitial radium therapy in terms of the same unit, if possible. By means of the erythema dose curve determined with implants in wax, just referred to, this could be done.

These curves actually give the change in intensity of radiation with distance from the source, along a line perpendicular to the implant at its center. If the implant is a seed or very small needle, it behaves essentially as a point source, except at extremely short distances, so that the distribution of radiation is the same along any straight line going out from the source, and the equal intensity surfaces (isodose surfaces) are spherical shells. (It is probably easier to visualize them in one plane; they are then circles.) However, for longer sources, these isodose surfaces become elongated, tending to be ellipsoidal, or the sections in a plane resemble ellipses, which are longer and flatter the longer the needle. In order to determine dosage at various points, it is necessary to know the values not only along the perpendicular to the tube already considered, but at all positions. To determine these values experimentally, for points too close to the source for ionization measurements, would be extremely tedious and difficult, whereas it seems reasonable that if calculated values are satisfactory for one direction, they will be for all. Such isodose surfaces have been calculated by a number of workers, for implants of a wide range of lengths and filtrations.[19,39,47,49,63]

Since in interstitial therapy it is seldom that a single source is employed, in order for accurate dosage determination at points within a tumor mass it would be necessary to know exactly the positions and orientations of every implant. Then, for any specific point, the dosage contribution from each source would have to be determined from the appropriate chart. This would be extremely laborious, even if possible, but it is very seldom that such a distribution within the tissues can be known accurately. However, in practice it does not appear nec-

essary actually to know the dose at every point throughout the mass. Other conditions being equal, it is obvious that if the cells which receive the *minimum* dose within the tumor are destroyed, then all those receiving greater doses will be also. Hence the dosage problem becomes that of determining the least dose delivered within the diseased region, in any particular patient.

Even for this, actual calculation in the given case is not practicable. However, it is possible to calculate this minimum dose, for certain definite sizes of tumor, and certain specific arrangements of seeds or needles. Further, it can be determined how much this minimum changes with certain shifts in the arrangement. Many such calculations were made at the Memorial Hospital for a wide variety of symmetrical arrangements of different numbers of implants in varying volumes of irradiated material. The first intensive studies were made with gold radon seeds.[50,54] In this series, it seemed most practical to consider all tumor masses as spheres, or combinations of spheres; it was found that if more than three seeds are implanted as uniformly as possible in a sphere, the minimum dose is delivered on the periphery. Slight variations from symmetrical or uniform distributions, when several seeds are used, do not produce unreasonably large variations in this surface dose.

Accordingly a dosage table was developed by means of which could be determined the number of milligram- or millicurie-hours of radium or radon, in very small interstitial sources, necessary to deliver a minimum of any desired number of erythema doses within a sphere of any reasonable size. With the cooperation of Dr. Hayes E. Martin and his associates,[38] the clinical applicability of this table was given a thorough test.

The extension of this dosage system and table to needles of various lengths was soon found desirable, and the necessary modifications were made for that purpose.[51]

No high degree of accuracy is possible in such dosage determinations, because of the difficulty first in measuring the exact size of the tumor mass, and second of placing the implants in exactly the proposed position. However, it is felt that doses determined by this method should not be in error by more than 15 per cent, which is not serious from a clinical point of view. The published tables have been widely employed by American radiologists ever since their appearance.

Recently, several years after the presentation of this dosage system, somewhat similar ones have been published in England by Paterson and Parker,[47] and in Canada by Laurence.[29] Their curves are based entirely on the calculations mentioned earlier. The shapes of these calculated curves are in good accord with those based on the experimental work at the Memorial Hospital.

They, however, chose to express their doses in terms of roentgens, in spite of the fact that at that time the gamma-ray roentgen was by no means satisfactorily established. They did not, themselves, attempt to establish it experimentally. Paterson and Parker simply accepted the value of the number of ion pairs produced per second by the gamma rays from 1 gram of radium in equilibrium with its products as determined by Gray, and published by Rutherford, Chadwick, and Ellis,[59] and calculated the corresponding number of roentgens as 8.4 per milligram-hour for the intensity of radiation at a distance of 1 cm. from a point source of radium filtered by 0.5 mm. platinum. Laurence took the average of published experimental values to be discussed below.

Consideration of the possibility of the specification of dosage in terms of roentgens leads to the second series of studies mentioned earlier, namely, the physical determination of the quantity of gamma radiation in terms of an ionization unit.

The roentgen is defined as that quantity of radiation which, by the complete utilization of its secondary corpuscular rays, produces a specified number of ion pairs per unit mass of air. (This is the number

which forms 1 electrostatic unit of charge, namely 1.62×10^{12} ion pairs per 0.001293 gram of dry air.) In the case of roentgen rays it is comparatively simple to construct an ionization chamber in which complete absorption of these secondary rays can take place. With gamma rays, the ranges of the secondary electrons are so great as to make the construction of this type of chamber practically impossible. Over a period of several years, various physicists attempted to develop open air chambers of the standard type, to measure γ-rays, and obtained values ranging approximately from 2 to 8 roentgens per milligram-hour.[2,15,27,40] Since the emission of radiation by radium is constant, it is obvious that these variations are due to the apparatus employed. In the comprehensive study of ionization measurements of γ-rays by Failla and Marinelli,[16] difficulties in the use of standard type chambers are analyzed in detail. It is shown to be questionable whether such radiations can ever actually be measured in roentgens by means of an open air chamber, because of the impossibility of excluding the scattered γ-radiation, and at the same time including all the secondary electrons. This is true even though it is possible to have a well collimated beam of γ-rays.

Since the use of a collimated beam in an open chamber proved unsatisfactory, studies were carried out with closed chambers, of various sizes, with very thin walls, placed at various positions in both collimated and uncollimated beams, by Failla and Marinelli,[16] Friedrich,[18,20] Kaye and Binks,[27] and others. In such a chamber, the ionization measured is dependent on the distribution in space of the secondary electrons. By definition, the roentgen requires complete utilization of these rays in the production of ionization. Even in a collimated beam of 200 kv. roentgen rays, some of the electrons generated within the measuring volume may pass outside it, but under correct geometrical conditions, an equal number which have originated outside this volume enter it. This *compensation* makes possible the use of open air chambers or very thin-walled chambers for such roentgen rays. In the case of γ-rays, the establishment of such compensation is not so simple. Close to the source, before a considerable volume of air has been irradiated, more electrons leave a unit volume than enter it and there is undercompensation. After a distance comparable to the ranges of the fastest secondary electrons, compensation is attained, but at still greater distances it has been found that over-compensation may exist; that is, more electrons enter a volume than leave it, and it is necessary to go to large distances to attain a truly uniformly irradiated space, where compensation is finally established. This whole subject has been theoretically considered by Lauritsen,[33] and by Failla and Marinelli;[16] the latter also carried out measurements up to a distance of 9 meters without getting outside the region of over-compensation. It was not until Friedrich[18] conducted his experiments in a hall $100 \times 50 \times 22$ meters that this matter was actually settled. With his chamber half way between floor and ceiling in this huge room, and using a collimated beam of gamma rays, he found that equilibrium was finally established at a distance of 20 meters from the radium. On the basis of these measurements he found a value of 7.8 roentgens per milligram-hour at 1 cm. distance from a point source of radium with a filter of 0.5 mm. platinum. This value was obtained by calculating the effect of distance on the basis of the inverse square law, and by applying a correction for the scattered γ-radiation.

Obviously it is impossible to find many rooms of this size available for experimental work, and it is important to develop some other method for conducting the measurements. If the matter of attaining equilibrium of secondary corpuscular radiation depends only on the number of electrons in the material traversed by the primary beam, the same result would be expected in a correspondingly shorter distance if the air were compressed. Friedrich, Schulze and Henschke[20] carried out measurements under pressures of several atmospheres (up to

50); their results confirmed this assumption. If this is true, it may be further assumed that it is not necessary to use compressed air, but that any air-equivalent material (air-equivalent as to the number of electrons per unit mass, and with no components of high atomic number) can be employed. That is, an ionization chamber of air-equivalent material, with a wall thickness providing the requisite number of electrons, should give the same measurement as a very thin-walled chamber in a very large room.

The actual thickness necessary has been determined by several investigators, notably Friedrich, *et al.*,[20] Failla and Marinelli,[16] and Gray.[24] The procedure is to make measurements with a very thin-walled chamber, over which can be slipped sheaths giving greater and greater effective wall thicknesses. The ionization in such a chamber is found to increase with wall thickness up to a point in the region of 3 or 4 mm., the exact value varying for different experimental conditions. Beyond this thickness it decreases again, due to the absorption of the primary radiation in the chamber wall.

Long before this careful work with thin chambers, small thimble-type "air-wall" chambers of the type developed by Fricke and Glasser[17] had proved so satisfactory in the measurement of roentgen rays that it was natural to try to use them for γ-rays. The first such measurements were published by Glasser and his associates in 1926; during the next decade others were carried out in a number of institutions. Considerable variations existed among the earlier measurements, due to difference in wall material and thickness, chamber volume, collimation of beams, etc., as well as to the inclusion of, or correction for, scattered γ-radiation. A long series of experiments by careful workers have established certain conditions which must be met for reliable results. The wall material must be of low atomic number, approximating that of air. The wall thickness must exceed the range in it of the fastest secondary electrons. The dimensions of the air volume must be small in comparison with the range in air of the ionizing particles. Employing suitable chambers of this type, various experimenters have obtained values from 7.6 to 8.8 roentgens per milligram-hour from a point source, at 1 cm. distance with a filter of 0.5 mm. platinum.[16,20,22,45,63] This is a variation of 15 per cent among values for something which actually does not vary at all. Hence it is evident that completely correct conditions have not yet been established.

Various experiments are being made to find these remaining experimental difficulties, with different special types of ionization chamber, in order to come to a final accurate value. Most promising among these experiments are those of White, Marinelli and Failla,[67] with chambers which are essentially very thin shells of air completely surrounding the radium source, which is first embedded in sufficient air-equivalent material to produce electron equilibrium. Around the radium container, a series of hollow spheres of different sizes can be mounted, giving air shells of varying thicknesses. The outer surface of the radium container and the inner surface of the surrounding shell, made electrically conducting by coating with aquadag, form the electrodes of the ionization chamber, and the ionization is measured in the intervening space. By means of the data thus obtained, it is possible to extrapolate to find the ionization in an infinitesimally thin air shell, thus eliminating any error due to size, shape, or orientation of air volume. Their result, 8.56 roentgens per milligram-hour at 1 cm. distance, for a point source filtered by 0.5 mm. platinum, must be considered the best at the present time. It is, as a matter of fact, quite close to the average of the values obtained by the workers mentioned above.

For the expression of radium dosage in terms of roentgens, then, this value can be used. However, before such a dosage scheme is generally adopted, it is essential that certain facts be realized.

First, any value for the roentgen equivalent of the milligram-hour must be regarded

as subject to correction. However, in the light of the most recent experiments just mentioned, any such correction will probably not be more than a few per cent, which is of little or no practical significance in a clinical unit.

Second, and more important, this value is correct only for points in the tissue surrounded by at least 4 mm. of organic material (the thickness of the measuring ionization chamber wall). That is, it is correct for interstitial irradiation, for the skin under wax mounds and similar surface applicators, etc. It is not correct for the skin in teleradium therapy, unless this is deliberately covered with a 4 mm. sheet of bakelite, celluloid, rubber, or some such organic substance. Without this cover the skin may receive less radiation, or more, depending on the degree of electron compensation. The source and filter may be so arranged that under-compensation exists, in which case the skin dose is low. On the other hand, there may be a considerable excess contribution of electrons from filter, cones, etc., so that there is essentially over-compensation and the skin dose is high. In neither case is it measured correctly. In the first instance, it is a clinical advantage not to use the compensating sheet of organic material even though it is then impossible to specify the skin dose. In the second, it is clear that it should be employed. The argument as to whether it is preferable to be able to specify the skin dose, which necessitates using the cover, or whether it is preferable to lower the skin dose by an uncertain amount by not using it has not been settled.

Third, and most important, it must be realized that while these γ-ray roentgens produce the same number of ions per unit mass of *air* as the standard roentgen-ray roentgens, the same effect in *living organisms* will not necessarily be produced by equal numbers of roentgens of the two types of radiation. The distribution of the ions as well as their number may be important, and this is quite different in the two cases. Actually, in some tissues considerable differences have been found in the results produced by the same numbers of roentgens of the two kinds of radiation.[1,14,16,52]

With these limitations, γ-ray dosage expression in terms of roentgens is now a practical method. It is done directly if the system employed is that of Paterson and Parker or of Laurence, or any other based on a statement of the output of a radium source in terms of these units. With a system based on erythema doses, such as that developed at the Memorial Hospital, one further step is necessary. This is to determine the number of these units which produce the standard erythema reaction for some one set of physical factors. As has been already stated, there exist in the literature several sets of tables relating the exposures required to produce equivalent skin reactions with sources of various sizes and shapes. Hence when the erythema dose for one of them is known in terms of roentgens, all the others can be specified in the same terms.

Such an evaluation of the erythema dose can be made from experimental data available at the Memorial Hospital, where many hundreds of roentgen-ray and radium skin tests for the purpose of determining erythema reactions have been carried out during the past twenty years. Out of this mass of material, the most suitable for the purpose are the values obtained from three different small radium applicators. In each case the erythema dose for the applicator, in milligram-hours or millicurie-hours was determined carefully in the course of another experiment, and values for all three are published.[36,50,53] When proper corrections are made to these doses for the facts that the sources were tubes instead of points, that the distances were not exactly 1 cm., and that the filters were not exactly 0.5 mm. Pt, the three values obtained for the erythema dose from a point source under standard conditions are 123, 132, and 116 mg-hr. Using White, Marinelli and Failla's factor of 8.56 roentgens per milligram-hour under the same conditions, the values for these doses become 1,050, 1,130, and 990 roentgens. The average of these,

1,060, should be a satisfactory conversion factor for transforming erythema doses into roentgens, or vice versa.

As a direct experimental check on this value, it was possible to construct a special type of ionization chamber (extrapolation chamber) around one of these applicators and actually measure the ionization at the skin under the conditions of the test.[53] This is essentially the instrument discussed by Failla[12] for measuring the ionization at the location where the radiation is utilized and under the conditions of treatment. The radium tube was enclosed in a catalin holder which, in the clinical experiments, was applied directly to the skin. The holder, coated on the outside with aquadag to make it electrically conducting, became the inner electrode. A series of outer electrodes were made of lucite cylinders, which could be mounted concentrically to the tube, the ionization being measured in the region between the two electrodes. As in the shell experiments of White, *et al.*, the extrapolation method was employed to find the ionization in a vanishingly thin air volume just above the skin, or essentially at the skin surface. By this direct method, the amount of radiation necessary to produce the erythema reaction was found to be 950 roentgens. This is in close agreement with the value of 990 roentgens obtained for this source by the use of the conversion factor.

The extreme variation among the three values quoted above amounts to 14 per cent. Since the experimental determinations of erythema dose cannot be considered to be closer than 10 per cent for any one applicator, the variations among these values are within the limits of experimental error. Furthermore, to use 1,000 instead of 1,060 as the conversion factor from erythema doses to gamma-ray roentgens introduces no significant error, and simplifies the procedure considerably.

It should be emphasized that this conversion factor refers only to gamma-ray doses, and for points in the tissue which are surrounded by at least 4 mm. of air-equivalent material. It does not refer to roentgen-ray doses. Furthermore, it is not correct to add roentgen-ray roentgens and gamma-ray roentgens and expect the sum to express tissue dose. For these reasons it has seemed advisable to the Standardization Committee of the American Radium Society to advise slightly different symbols for the two.[66] Since the ordinary lower case letter r is the accepted symbol for the roentgen-ray roentgen, the committee suggests the use of the letter r with a subscript γ, r_γ, for the gamma-ray roentgen. There will then be no confusion as to which is intended or as to how a given tissue dose is divided between the two.

The objection to the use of gamma-ray roentgens in expressing dosage is largely overcome by this simple precaution. The statement sometimes made, that because it requires quite different numbers of roentgen-ray and gamma-ray roentgens to produce a skin erythema, and probably also to produce other biological reactions, the gamma-ray roentgen should not be used as a measure of dosage, is not a complete statement of the difficulty. The difference between the number of 200 kv. roentgen-ray roentgens and 100 kv. roentgen-ray roentgens required to produce a skin erythema is considerably greater than that between 200 kv. roentgen rays and gamma rays.[34,35,42,52] Furthermore, it has been shown that in the production of erythema, doses of gamma rays and roentgen rays of various qualities are not strictly additive, but that it requires more of a combination of the two in equal parts than of either one alone.[55,56] It is evident from these considerations that, with regard to the skin dose, at least, the addition of roentgens of different qualities of radiation, whether roentgen rays or gamma rays, has no accurate meaning. For other human tissues there is at the present time little definite information. But certainly in the light of the skin effect, and of the results of laboratory investigations on various biological organisms, caution is indicated in the indiscriminate use of the roentgen as a dosage unit. This caution is just as applicable to roentgen rays of various qualities as to gamma rays. The desire to simplify the dos-

age problem is natural, but it must not be allowed to lead to inconsistencies or to gross inaccuracies.

This is not to be interpreted as a suggestion that the problem cannot be solved. As a matter of fact, the material reviewed briefly in this paper shows that between the completely chaotic state of radium dosage specification twenty years ago, and the present desire to avoid inaccuracies of a few per cent, a great gulf has been crossed. The Standardization Committee of the American Radium Society, recognizing the value of the existing information, and the desirability of its consistent employment by radiologists, has issued a report placing radium dosage specification on a formal basis.[66] It is to be hoped that with the aid of this, and similar documents, a uniform system of practical radium dosimetry may be established.

It has been the intention in this paper to point out the salient facts in the development of useful methods in the specification of radium doses. Due to the extent of the literature on the subject, and to the intricate technical nature of many of the experiments, such a review must necessarily be incomplete. It is believed, however, that the essential points have been covered from both the physical and clinical points of view. The practical worth of any dosage system can only be determined after it has been employed for a sufficient period.

In closing, I wish to express my pleasure at being able in some measure to pay my tribute to Dr. Janeway, one of our real leaders. And I thank the American Radium Society for having chosen to give me this honor.

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PRESENTATION OF THE JANEWAY MEDAL

By ZOE A. JOHNSTON, M.D.

The members of the American Radium Society and their guests who were privileged to listen to Edith Quimby this afternoon are familiar with the purpose of the Janeway Lecture. To our guests tonight, I desire to say that Dr. Janeway was a pioneer in the use of radium as a therapeutic measure. The members of the American Radium Society have a grateful appreciation for the splendid foundation which he built for those who follow in his footsteps. They wish to keep his memory alive, and each year invite one who has made a contribution to some phase of radium work to deliver the lecture at the annual meeting.

We naturally receive inspiration from the accomplishments of others. Especially is it true if outstanding original work is required as a basis. This generation is too prone to live in the present. We may look forward to the future, but many times we are impatient with those who recall the past. By naming this lecture the Janeway Lecture, we hope to keep ever before us the example and influence of Dr. Janeway.

It is our custom to present a bronze medal to each lecturer as a memento of the occasion. The sentiment on both sides of the plaque expresses interesting Nordic mythology. Mimir was a giant water divinity and a keeper of the well of wisdom and understanding. Odin went to Mimir and requested a drink from the well. He sought knowledge, especially of the future. Mimir withheld this until he had been given a pledge. Odin gave one of his eyes as a pledge. Odin, with one eye, is revealed on one side of the plaque; on the other is shown Odin with his two ravens, "Thought" and "Memory." They sat on his shoulders and whispered to him about all that they saw and heard. He sent them forth at daybreak to fly about the world. They returned at night and told him about the things they had seen, especially new discoveries. No doubt, the ravens whispered the news about the discovery of radium to Odin.

The members of the American Radium Society feel highly honored to have the opportunity to present the Janeway Medal to Edith Quimby. Her scientific accomplishments have been of the utmost importance. Her influence is far reaching. As you may know, much of her work is in the field of research. Her straight thinking, precision as to detail, and an enthusiastic spirit are qualities which have enabled her to give such important contributions to the field of radiation therapy.

Radiologists come to her with their problems. However, I am confident that her greatest influence is with the younger men who have entered this field of endeavor. As these young men come and go through the institution with which she is connected, their contacts with her through lecturing, teaching, and constant association give them a scientific background for their future work. It would be impossible to estimate the value of this fundamental training.

In addition to the scientific, there is another side to Edith Quimby—the woman, the warm friend, the charming wife, the hostess, clever in unexpected lines of endeavor far from the field of physics and research. I am proud to say that she has the faculty of making friends and of creating a feeling of happiness and good cheer. We have in Edith Quimby the unusual combination of a scientist and a charming personality.

Dr. Edith Quimby, in behalf of the American Radium Society, I am happy to present you with the Janeway Medal.

THE CRANIAL AND INTRACRANIAL EPIDERMOIDOMAS

FROM A ROENTGENOLOGICAL VIEWPOINT

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TO UNDERSTAND the changes seen in the roentgenogram produced by cranial epidermoids, we must be thoroughly conversant with the pathology of such tumors. Hence, let us first try to answer the question, "What is an epidermoid cyst?" Broadly speaking, the epidermoid is similar to the dermoid tumor, with the exception that it does not contain definite dermal tissue, and macroscopically the epidermoid usually will present a more lustrous pearly sheen. The name is derived from the apparent fact that the tumors originate in cell rests of epithelial origin, and it was von Remak who, in 1854, first suggested such an "anlage," but it was Veratus who was probably the first to recognize these tumors. He commented upon their appearance in 1745. Somewhat later, in 1807, Duméril gave a more detailed description of an epidermoid. Love and Kernohan make a point of differentiation between dermoids and epidermoids by pointing out that the true epidermoids will contain epithelial tissue of the squamous and basal cell types, whereas the dermoid cyst will contain one or more of the following list of structures: sweat and sebaceous glands, hairs and hair follicles. The epidermoid tumors are usually considered as being relatively benign, but cases have been reported in which the wall of the epidermoid has harbored or given rise to a carcinoma or even a sarcoma.

Epidermoids are usually well encapsulated and are covered by layers simulating the skin of an onion, and these layers constitute the living portion of the mass. King describes three layers, an outer skin consisting chiefly of acellular connective tissue, under this a middle layer composed of stratified squamous epithelium, and an inner layer formed of cornified epithelium. Bailey describes four layers, designating them the stratum durum, the stratum granulosum, the stratum fibrosum, and the stratum cellulosum. The central and major portion of the tumor consists of epithelial debris with cholesterin, and it is because of the presence of cholesterin that the tumors are frequently called cholesteotomas.

The origin of the epidermoids has been fairly well established as being from groups of cells which might be thought of as ectodermal rests. In fact, there have been reports of such tumors maintaining their connection with the surface epithelium and so permitting infectious organisms to enter. What starts the cell rest on its career is still a question. In some parts of the body such lesions evidently are intimately associated with trauma, such as the palmar surfaces of the hands of laborers. It is quite possible to produce an epidermoid experimentally by implanting epidermal tissue beneath the skin, but an association with trauma is not easy to establish in the usual case of a cranial epidermoid, especially the tumors found intracranially, with the possible exception of those occurring within superficial cranial structures and the frontal sinuses.

The growth of an epidermoid is very slow and noninfiltrative. Some cases give histories extending over periods of ten or more years. Because of this slow and at times almost asymptomatic growth, the cranial lesions may become relatively large and therefore difficult to remove, which is most unfortunate because a complete removal eliminates any possibility of recurrence. The tumor does not infiltrate and so merely displaces brain tissue, but even though the outer layers of the tumor are quite friable, its growth is so inexorable that it will erode and destroy any unyield-

ing tissue like bone with which it may come in contact.

The occurrence of cranial epidermoids, with the exception of those found in the middle ear, is very uncommon. In Frazier's series of cases 0.13 per cent were suffering from epidermoids, and in Cushing's series of 2,004 brain tumors, only 0.6 per cent were epidermoids. There appears to be no cranial or intracranial area entirely immune to the possible presence of one of these tumors. Jefferson and Smalley collected from the literature 179 cases of epidermoid tumor, including 6 of their own, and with the exception of 8 which were intraspinal, they were distributed as follows:

Para-pontine	63	Diploic	30
Para-pituitary	49	Pineal	1
Fourth ventricle	21	Suprasellar	1
Lateral ventricle	6		

From this it can be seen that the site of election is along the base of the brain and the brain stem, with the tumor often extending into the cerebellopontine angle. It was the pearly sheen exhibited by the intracranial epidermoids when exposed at operation, that led Cruveilhier to call them "pearly" tumors. From a perusal of the literature it becomes clearly evident that there is no special age at which cranial epidermoids are most apt to occur, but it is of interest to note that such tumors are found in males more frequently than in females.

When attempting to make a diagnosis of the presence of an epidermoid, it is of considerable importance to have a good history of the case, and as many as possible of the clinical findings. The usual long, slowly progressive history and rather vague but malignant symptomatology will help in narrowing the search to a relatively few possibilities, among which would be an epidermoid.

A little over 12 per cent of the cranial and intracranial epidermoid cysts will be found within the ventricles. If the tumor were in the fourth ventricle we would find only generalized evidence of increased intra-

Fig. 1. Epidermoid cyst of the right parietal bone showing the typical well defined margin of the bone defect. This tumor was confined to the diploe

cranial pressure. In this connection it might be well to consider that the pineal gland may be displaced posteriorly in spite of the fact that the tumor is subtentorial. This displacement is due to the dilatation of the third ventricle with consequent pressure against the anterior portion of the pineal body. The tumor may contain sufficient calcium to cast a shadow on the roentgenogram. When calcium is present it is usually within the shell-like layers forming the outer portion of the tumor mass, hence in good stereoscopic films a globular form to the shadows might be recognized.

It would be very difficult to make a definite diagnosis of an epidermoid below the tentorium even though it were calcified and cast a shadow, because such a shadow would more probably be produced by an astrocytoma, an ependymoma, a tuberculoma, or even one of the blood vessel tumors. A ventriculogram would not be expected to help much in a differential diagnosis. It would merely demonstrate quite clearly the presence of a block of the

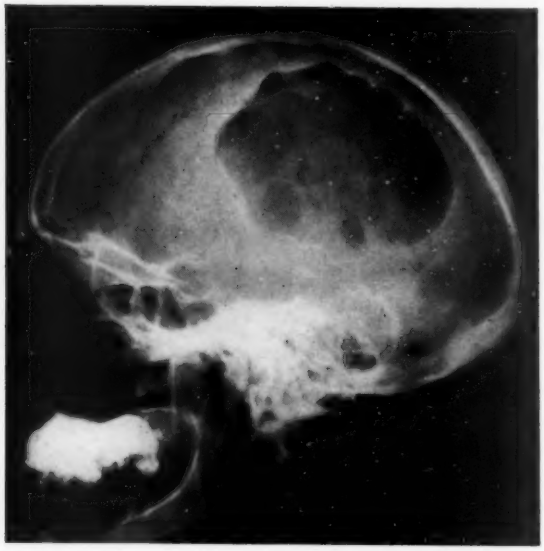

FIG. 2. Epidermoid cyst of the right parietal bone. Note the well defined scalloped margin of the bone defect.

cerebral fluid pathways below the tentorium. If the tumor were within one of the cerebellar hemispheres we would still have no more differentially diagnostic evidence of its presence than has been mentioned above.

An epidermoid tumor may be found in the choroid plexus of a lateral ventricle. When so found it is apt to involve the glomus, which is the portion of the plexus so frequently seen to contain benign deposits of calcium. If these deposits of lime salts are exceptionally large, and particularly if they are asymmetrical or even unilateral, one might be justified in suspecting the presence of a pathological condition. In any event, the history would have to play an important rôle because the glomus of the choroid plexus may be quite large and calcified without being pathological. An ependymal tumor, a papilloma, or even a vascular anomaly might produce an identical shadow in the roentgenogram. An encephalogram would show more clearly the outline and size of a mass in this location, and if the gas were in contact with the irregular surface of the tumor a serrated outline might be seen which would be very suggestive and almost pathognomonic.

An intraventricular tumor will usually originate in the wall of a ventricle or immediately adjacent to it, and may become very large and invade more than one ventricle. A tumor of this type was described by Dyke and Davidoff with what they consider typical encephalographic findings. These findings were "numerous globular and linear collections of gas in the positions normally occupied by the Isle of Reil, the thalamus, the temporal lobe, and the posterior portion of the right frontal lobe." Such a distribution of gas is undoubtedly highly significant, but whether or not it is absolutely pathognomonic of an epidermoid will have to be determined after a few more of these rare tumors have been diagnosed from similar findings. However, if the serrated tumor outline can be demonstrated, and this is usually possible when at least part of the mass is within the ventricle, then as these authors have inferred, the diagnosis is practically certain.

According to Jefferson and Smalley, about 17 per cent of the cranial epidermoids involve the diploe, and it is these tumors that we are able to diagnose most readily. Cushing was either the first or among the few who first associated certain defects in the skull bones with epidermoids. His description of such defects was published in 1922. The tumors producing these defects may be intracranial but extradural, intradiploic or extracranial but in contact with the outer table. In any case, the bone changes will be quite comparable and will consist of a more or less irregular area of bone destruction due to pressure atrophy. The margins of the defect may be serrated or fairly regular, usually the former, and not infrequently will be composed of dense bone which at times can be felt on palpating the skull, as a bony ridge. If a tangential film of the lesion be obtained, the bony ridge of the edge of the lesion nearest the film will be seen, as pointed out by King, as a dense line passing through the defect.

If the tumor originates extradurally, it will produce, in its early stages, a greater defect of the inner table than those orig-

inating more externally, particularly if the middle or diploic table be quite thick. And, in addition, the clinical symptoms would be greater because the brain would be more markedly indented. The lesion originating in the diploe would involve both inner and outer tables to about the same extent, depending slightly upon their comparative thickness. The tumor originating under the scalp may produce relatively little bone atrophy because the tissues of the scalp yield easily to the expansion of the mass. The extent of the bone atrophy depends also upon the thickness or density of the outer table of the skull. The size of the bone defect is not always an indication of the size of the tumor which is often much larger.

The formation of a bony ridge about some of these tumors after they have destroyed considerable bone is decidedly a "bone of contention." This bony ring is not always atrophic and must form by a flaring of the edges, and the increased density seen in the film is at least partly due to a summation of shadows due to the overlapping of the flared margins.

If the bony defect does not show the almost pathognomonic bony ring in the roentgenogram, then we cannot be so sure of the diagnosis. Leptomeningeal cysts may produce almost identical calvarial defects, and as such cysts are almost always the results of trauma, the preoperative differential diagnosis from an epidermoid might be well nigh impossible. The epidermoid, however, would be expected to be associated with a much longer history than the meningeal cysts which usually form within one to three years after the original injury.

The epidermoids occurring in and about the frontal sinuses, and those involving the bones of the base are not so apt to be surrounded by a bony ring. In the frontal region a retention cyst may produce a very misleading bone defect and one that might well necessitate a biopsy to differentiate it from an epidermoid. Lesions caused by metastatic tumors may prove confusing at first glance, but the margins of such lesions

Fig. 3. Epidermoid cyst of the meninges eroding the posterior wall of the right orbit (greater wing of the right sphenoid bone). Note the smooth margins of the kidney shaped defect.

are usually fuzzy and atrophic. The relatively short history of such tumors and their rapid progress would rule out an epidermoid, and in addition the usual multiplicity of the metastatic lesions would be against an epidermoid, even though epidermoids might be multiple, but such a contingency would be remote.

When we encounter localized areas of bone atrophy involving the bone forming the floor of the middle fossa on either side, and if the case history is very vague and covers a period of several years, we might then be justified in considering the possibility of the presence of an epidermoid. Defects in the bones forming the floor of the middle fossae are more likely to be caused by some malignant process such as a transitional cell epithelioma (Schmincke tumor). With such a tumor, however, the history would be relatively short and the margins of the defect would have a "malignant" ill defined appearance. Still another tumor which can produce a bone defect not unlike that associated with an epidermoid is the xanthoma of reticulo-endothelial origin. The bone defect produced by such a proc-

FIG. 4. Epidermoid cyst of the vertical portion of the left frontal bone and roof of the orbit.

ess may occur anywhere in the skull bones and is apt to be multiple. A bony ring about such a lesion is not likely to be found, but due to the complete absorption of bone within the lesion, the margins of the defect may appear quite dense because of the marked contrast. This is particularly true when the lesion is close to or involves the foramen magnum, or is in a rather dense calvarium. The history of xanthomatosis, with the usual accompanying symptoms of exophthalmos and diabetes insipidus, would easily permit of differentiating such lesions from epidermoids. We must continually bear in mind, however, the possibility of more than one disease process being present in the same individual, so that when more than one bone defect is noted each must be studied separately and carefully.

A cerebral epidermoid occurring in or near the middle fossa on either side is very apt to produce a depression of the floor of the fossa as compared to the opposite side. This may also be true of the anterior fossa, and as the epidermoids often attain considerable size the sella turcica is likely to show pressure atrophy of the side nearest the tumor. The fact must not be lost sight of that a chronic hematoma can produce similar changes. It would be wise also to examine the optic foramina, for so often in the presence of tumors in or near the middle fossae and sphenoid ridges, the optic foramen on the involved side will show atrophy and enlargement. Occasionally an epidermoid will be found immediately above the sella turcica, perhaps under the optic chiasm. When such a tumor is so located we will usually find no characteristic change in the roentgenogram which would permit making an unequivocal diagnosis. The changes would be merely some general atrophy of the tuberculum sellae.

Suprasellar epidermoids apparently are more apt to be found in young people, and if calcified they may so closely simulate the more common craniotuberal cyst or craniopharyngioma, optic chiasm glioma or even meningioma, that we would be unlikely to think of an epidermoid. If the bone exhibited a definite, clear cut defect we might be justified in considering an epidermoid as a probable diagnosis, particularly if the history suggested a congenital lesion and there were evidences of primary optic atrophy. Encephalography would not be expected to add much to the differential diagnosis. It would merely show the presence and perhaps indicate the size of the mass by revealing deformities of the basal cisterns, and if the tumor were large, a deformity of the third ventricle and perhaps the anterior horns of the lateral ventricles.

According to Jefferson and Smalley's figures, about 40 per cent of the intracranial epidermoids will be found along the brain stem, and perhaps extending into the cerebellopontine angle. Tumors in such locations are usually very difficult to recognize in the roentgenogram, and unless they have eroded the adjacent bone or become calcified they may well go unrecognized. The pineal gland might be displaced away from the site of the tumor, and an encephalogram might show a distortion or dis-

placement of the cisterna pontis, the aqueduct or the cisterna interpeduncularis. With the exception of bone erosion, such variations from the normal would not necessarily make one think of an epidermoid. If such a tumor finds its way into a cerebellopontine angle, it may erode the petrous pyramid in such a manner that we would be led to misinterpret the evidence seen in a roentgenogram as being caused by a neurinoma of the eighth cranial nerve, a tumor considerably more common than an epidermoid. A lumbar puncture might help in making a differential diagnosis. In the presence of an eighth nerve tumor the total protein in the spinal fluid probably would be increased, whereas in the presence of an epidermoid no such increase in protein would be expected, particularly if the tumor were chiefly if not wholly within the petrous pyramid.

The literature is filled with more or less conflicting views regarding the origin and nature of the epidermoids occurring in or near the middle ear, and its adnexa. It seems highly probable that at times we may find a true primary epidermoid in such a location, but the commonly found, foul smelling tumefaction in the middle ear and mastoid antrum had best be termed, for the present at least, a cholesteatoma or perhaps a secondary epidermoid. This latter type of tumor is almost always associated with a chronic infection, and is supposed to originate from stratified squamous epithelium which has grown through a defect in the ear drum. Tumarkin is very insistent in his views which are forcefully developed in an excellent article. He is convinced that all cholesteatomas of the mastoid and antral areas are due to inflammatory reactions of pavement epithelium. Occasionally, however, an epidermoid will develop entirely within the petrous pyramid without any preceding history of middle ear or mastoid infection. A group of such tumors was reported by Jefferson and Smalley, which interestingly enough were associated with a slowly progressive facial weakness.

In several reports of large series of cases of otitis media, it has been shown that a large proportion of chronic cases develop cholesteatomata, but it is apparently often impossible to demonstrate the presence of squamous epithelium in these tumors, hence they cannot be termed indiscriminately epidermoidomas. It is not uncommon to find these lesions in both petrosa, hence films taken for comparison of the two sides must be interpreted with care because a tumor may be present on the unsuspected side even though there is no history of ear trouble. The usual size of a mastoid antrum as seen on the roentgenogram is about 6 or 8 by 10 mm., and should be rather well defined. Any appreciable variation from such size and appearance should arouse one's suspicion.

In examining the petrous pyramids we must not be satisfied with only one or two views, but should obtain films from various angles including the Towne and Stenvers positions taken stereoscopically, and it must be borne in mind that all dense sclerotic petrosa and mastoid processes are not the result of past infections, for in a fair

Fig. 5. Epidermoid cyst. Same case as Figure 4, posteroanterior view. Note the large defect involving the vertical portion of the left frontal bone and the roof of the orbit.

percentage of cases such a finding is merely evidence of agenesis. There never were any air cells. About 85 per cent of individuals have bilateral cellular mastoids, whereas about 10 or 15 per cent will present an acellular mastoid development on one or both sides. How can we differentiate between a sclerotic and an agenetic petrous pyramid? At times this may be impossible, but if we see on one side a normal-appearing petrous pyramid and mastoid cells, while on the other side the petrous pyramid is obviously smaller and the cells appear "sclerotic," it is highly probable that the small pyramid is hypoplastic and not necessarily the result of infection. The asymmetry of the petrosa in the presence of an asymmetrical cerebrum must also be considered. If both petrous pyramids contain normal-appearing air cells, but one petrous ridge is higher due evidently to hyperaeration, then probably we are dealing with an hypoplastic cerebral hemisphere. But if one petrous pyramid is small, due to a lack of development, then it might be difficult to recognize hyperdevelopment in the other, and additional signs of skull asymmetry would have to be sought before considering the possibility of the variation being due to an asymmetrical cerebrum.

An epidermoid within a petrous pyramid may be recognized in the roentgenogram by the presence of a localized area of diminished density usually in or near the mastoid antrum and occasionally the mastoid emissary vein will be enlarged as compared to the opposite side. A differential diagnosis between such a lesion and a metastatic tumor would rest almost entirely upon the slow progress of the lesion in one case and the rapidly progressive history in the other. It is quite possible that planigraphy may prove valuable in demonstrating the extent of these purely destructive lesions within the petrous pyramids.

SUMMARY

The cranial and intracranial epidermoidomas have been discussed as to their etiology and course. It seems evident that those occurring in the petrous pyramids are of two types, primary and secondary. The diagnosis of the epidermoidomas from the roentgenogram has been considered and various diagnostic criteria pointed out.*

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LEIOMYOSARCOMA OF THE ESOPHAGUS*

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MUSCLE cell sarcomas of the esophagus are quite uncommon. Eighteen cases have been reported since Chapman's[1] in 1877. The majority of these were rhabdomyosarcomata, the ones composed of smooth muscle cells being quite rare.

Howard[7] described the first esophageal leiomyosarcoma in 1902. Von Hacker's[5] report of Eppenger's case in 1908 was the second, and was included in a survey of the 21 cases of sarcomas of all types (muscle, round cell, and so forth) previously reported in that location. In 1935 Mallory[12] reported a case, and in 1937, Menne and Birge.[14] Quite possibly others may be included among the cases listed at the end of this report, but were classified simply as spindle cell sarcomas, without further differentiation.

The following case is reported as an addition to the 4 cases of smooth muscle sarcoma previously described in the literature. Its somewhat deceptive roentgen appearance and unsuspected circumscription are worthy of note.

The patient, E. N., was a tailor, aged seventy, seen February 17, 1939, on account of trouble with swallowing for two months. In December, 1938, he had noticed that food went down slowly and caused a burning feeling in his back and chest. The discomfort went away after two or three weeks; but he continued to have difficulty in swallowing, and finally took only a liquid diet. He had had moderate anorexia and loss of weight during this time, had occasionally felt hot at night, and had had a slight cough and complained of a coated tongue.

His past history was not remarkable except for a fracture of the right femur three years before, with a normal convalescence. A brother had died at the age of fifty-seven from cancer of the throat.

Examination showed a lean, wiry old man who had lost some weight, but did not look very ill. His temperature was 100.6° F., pulse 108, respirations 18 per minute. There was a medial opacity in the right eye; the tongue was coated and was somewhat smooth at the edges; and there were some carious lower teeth. A few crackles were heard at both lung bases posteriorly. Except for external hemorrhoids no other abnormalities were found.

Laboratory studies showed a hemoglobin of 72 per cent (12.2 gm.), 4,010,000 red blood cells, 11,050 white blood cells with a normal differential count. The urine had a specific gravity of 1.022, 10 white cells and 5 red cells per high power microscopic field, and an occasional hyaline cast. The blood Wassermann reaction was negative.

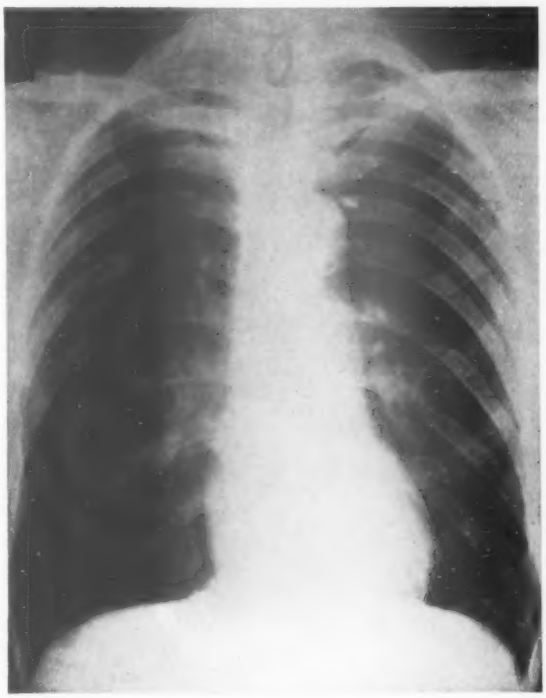

FIG. 1. Roentgenogram of chest showing bilateral upper lobe scarring and a few calcified lesions throughout both lungs, but no evidence of metastasis. The esophageal barium shadow is not visible in this reproduction.

Roentgen examination of the chest and esophagus (Feb. 17, 1939) disclosed the following:

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"The cardiovascular shadow appears normal in size; there is a little scarring and calcification in both upper lobes; the diaphragm is normal. There is a smooth constriction at the distal end of the esophagus, with dilatation of about 4 cm. in diameter above this point. The margins of the dilated area are smooth but there are several large filling defects within it; since these are spread over a wide area, it seems more likely that they are due to boluses of food than to tumor, but examination following esophageal lavage would be necessary to decide this point. *Conclusion:* Constricting lesion of the distal end of the esophagus, possibly benign, but malignancy not to be excluded without direct examination" (see Figs. 1 and 2).

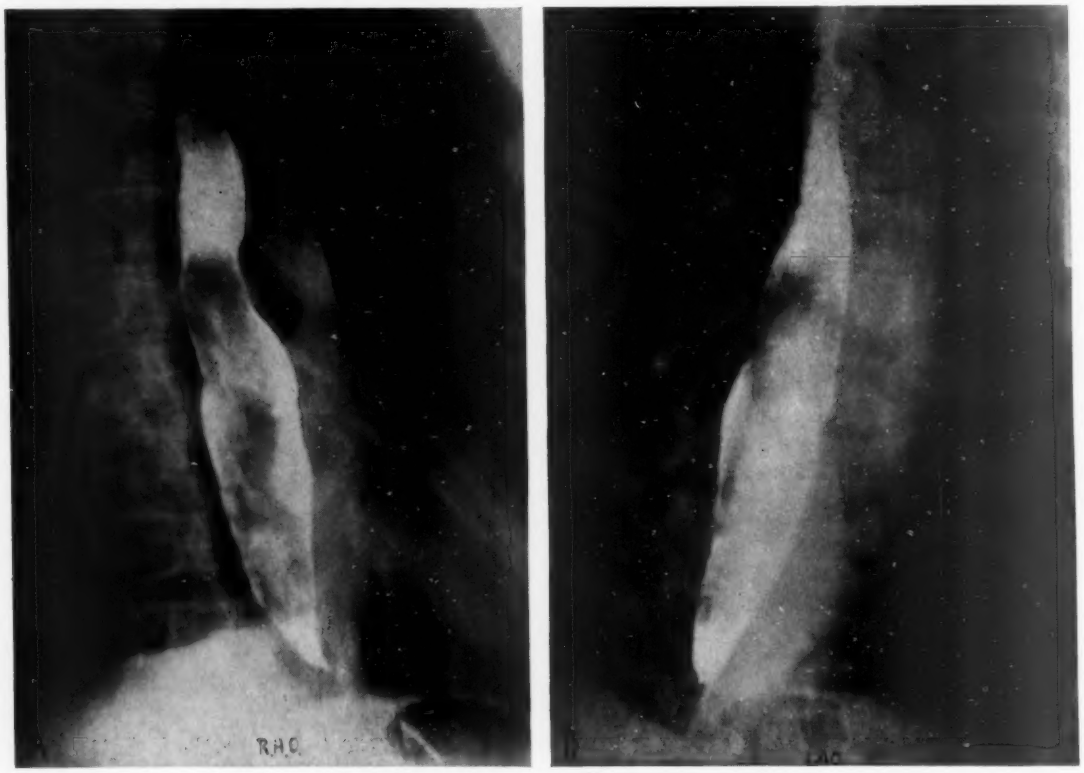

FIG. 2, *A* and *B*. Esophagus outlined with barium suspension, showing moderate dilatation of its major portion, smooth narrowing of its cardiac end and many filling defects. These were interpreted as boluses of food, or less likely, tumors, and were subsequently shown to be due to a large pedunculated single tumor—a leiomyosarcoma.

On February 20, esophagoscopy was done by Dr. Robert McNaught. There was considerable dilatation of the esophagus, and at a distance of 27 cm. from the incisor teeth a grayish mass was encountered. It was soft and friable, and was mistaken for lumps of food until it began to bleed freely. This tissue occupied the lumen for 10 cm., and seemed to arise from the posterior wall. The esophagoscope passed the mass without difficulty, and beyond it revealed smooth walls which seemed somewhat narrowed.

A biopsy specimen (at 30 cm. from the incisor teeth) was diagnosed carcinoma of the esophagus. It showed masses of necrotic tissue with some clumps of cells in which the nuclei varied greatly in size and intensity of staining; there was no alveolar or glandular arrangement. Large nucleoli and rare mitotic figures were present.

The patient became steadily weaker and more wasted. At one examination on March 9 there was auricular fibrillation; but the rhythm was normal at the next visit. During the last ten days of his illness he was troubled by phlegm in his throat, and occasional coughing spells; he had no pain. He died on May 23, six months after his first symptoms.

At autopsy the esophagus was dilated to a

Fig. 3. Photograph of the gross specimen showing the extensive esophageal tumor, measuring about 20×4 cm. in its maximum dimensions.

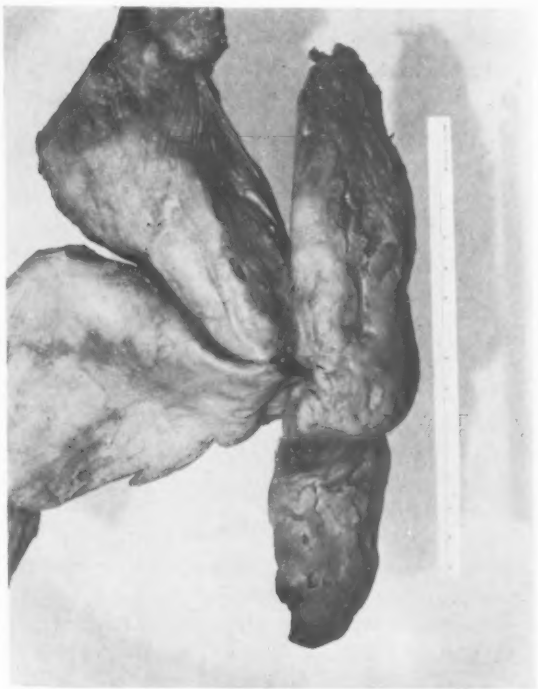

Fig. 4. Another view of the gross specimen showing the pedunculated nature of the tumor. Note the smooth esophageal wall at the base of the growth.

Fig. 5. Photomicrograph (approximately ×4) of a cross section through the tumor at the level of its pedicle, showing the non-invasive nature of the growth.

circumference of 12 cm., and its lower 20 cm. contained within the lumen a smooth, rubbery, sausage-shaped mass about 4 cm. thick. This was attached by its midportion to the posterior esophageal wall, 10 cm. above the cardia; there was no infiltration or thickening at the base of this narrow pedicle. The main tumor was grayish to dark red in color, and the surface showed several irregular furrows and rounded prominences (Figs. 3 and 4). There were no metastases, nor was there extension of the growth into adjacent regions.

Fig. 6. Photomicrograph (approximately ×60): Note the edge of the muscularis mucosae in the upper left hand corner, and the submucosa which formed the boundary of the tumor, at the base of the section.

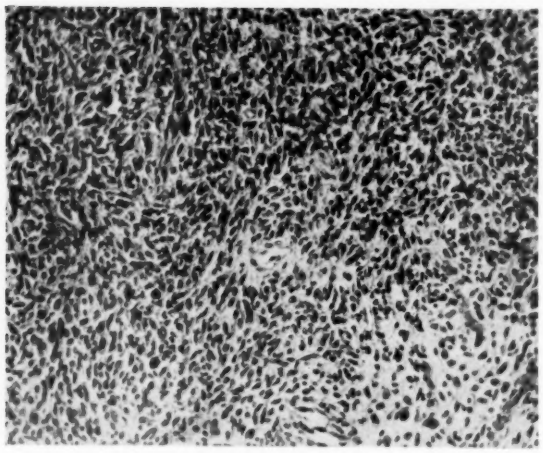

FIG. 7. Photomicrograph (approximately ×240) showing cells of many different shapes, held together in a heavy fibrous stroma; most of the cells are elongated, with nuclei of varying shapes and size, some multiple.

Microscopic examination showed the base of the pedunculated tumor to be continuous with the muscularis mucosae. The cells were of many different shapes, held in a heavy fibrous stroma. Most of the cells were elongated, with nuclei of varying shape and size, some multiple. A moderate number of mitotic figures were seen, and blood vessels were numerous (Dr. William Dock). The microscopic appearance is shown in Figures 5, 6 and 7.

COMMENT

From a survey of the small group of reported esophageal leiomyosarcomas it is apparent that they may infiltrate extensively or remain a practically non-invasive polypoid structure. In most instances they have been considered to arise in the submucosa. They may be accompanied by severe pain deep in the chest, in the back, shoulders or arms, even when no metastases or notable extensions are found; or they may be entirely painless, as in our case. There may be the briefest possible clinical course, or one of ten years' duration. *The polypoid tumors are readily mistaken for masses of food, both on esophagoscopic and roentgen examinations.*

An occasional sarcoma of this type may behave in a relatively benign fashion, causing mischief only by the fact that its bulk offers an obstruction to the passage of food. Such a tumor might offer a less hopeless therapeutic problem than usual if its actual character were suspected; but the reported cases afford no distinctive features on which to attempt a differentiation. As in bulky tumors elsewhere in the gastrointestinal tract, mere size alone should not deter careful examination with a view to complete extirpation, if there appears any possibility that the tumor is non-invasive. The technical problem of extirpating a low esophageal neoplasm remains, of course, a more formidable one than that of gastric or small bowel lesions. The age and condition of our patient would probably not have permitted radical removal. Owing to his clinical condition, the initial biopsy report and other factors, radiation therapy was not employed, but might well be used, especially as a preoperative measure, in cases of similar nature.

SUMMARY

A case of primary leiomyosarcoma of the esophagus is reported in a man seventy years of age. This is the fifth case of this particular type of tumor to be described in the literature. As in some of the other reported cases, the tumor was long and polypoid, and, at first glance, simulated boluses of food both on roentgenoscopic and esophagoscopic examination. The initial biopsy specimen was erroneously reported as carcinoma, but subsequent postmortem studies revealed the true nature of the growth. Although bulky and partly ulcerated, the tumor had not invaded the deeper layers of the esophageal wall and might have been removable had the true pathological condition been suspected.

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THE CONUS ARTERIOSUS AND THE PULMONARY ARTERY

AN IMPROVED METHOD OF VISUALIZATION*

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THE recognition of structural changes in the conus arteriosus and in the intrapericardiac portion of the pulmonary artery, despite the fact that they are confined to a relatively small area and readily demonstrable by roentgenography and roentgenoscopy and notwithstanding the continual improvement in roentgen technique, still present great difficulties in roentgen diagnosis. Likewise, the question of the development of an accentuated pulmonic arch in a healthy person has as yet not been satisfactorily explained. The inability to interpret existing similar roentgenographic changes in health and disease becomes apparent to one who examines a large number of cases.

Normally,[10] the conus arteriosus forms a small pouch which is situated at the extreme upper left angle of the right ventricular cavity and at its summit gives rise to the trunk of the pulmonary artery. When viewed roentgenoscopically or roentgenographically it presents the following features: In the anterior silhouette, it appears as a portion of a small flat arch which lies between the semicircular curve of the aorta above and the large elliptical curve of the left ventricle below. The craniad portion of the flat arch is formed by the stem of the pulmonary artery and the caudad portion by the conus. Occasionally, the left auricular appendage may be seen between the flat arch of the conus and pulmonary artery and the curve of the left ventricle. When the structures are observed in the right anterior oblique position, the ventral view presents the second or pulmonic arc between the curves of the aorta above and the right ventricle below. The conus is about 2 inches in length and 1 inch in diameter, and is longer in vertical and shorter in transverse hearts. It must be remembered that the structures in question lie in the region of the root or hilum of the left lung within which are merged numerous shadows of the large pulmonary vessels, bronchi, lymph nodes, connective tissue, etc. In other words, it is composed of heterogeneous components which may easily distort the normal heart configuration and produce considerable variation in the roentgen appearance.

Pathological changes in the conus and proximal portion of the pulmonary artery are almost invariably associated with right cardiac embarrassment. The most typical abnormal shape which the heart takes on is the so-called "mitralized configurated heart." This is characterized by accentuation of the pulmonic arc and its craniad displacement due, probably, to dilatation and hypertrophy of the right ventricle and globular enlargement with some bulging of the right lower border. Next to mitral lesions, the typical configuration is observed in congenital heart disease. Generally, alteration in the components which produce increase of pressure in the lesser circulation may result in actual structural changes in the conus and pulmonary artery. For this reason, the heart of mitral configuration is readily seen, in addition to mitral stenosis, in congenital heart lesions,[19] kyphoscoliosis,[2,6] pulmonary emphysema,[4] pneumoconiosis,[16] fibrotic tuberculosis,[8] arteriovenous aneurysm,[7] etc.

Other diseases, not necessarily associated with abnormalities in the lesser circuit, may also bring about the typical roentgeno-

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graphic findings seen in mitral heart disease, viz., beriberi,[13] scurvy,[17] any severe secondary anemia and particularly pernicious anemia,[3] thyrotoxicosis[14] and neurocirculatory asthenia. In some of these cases, as for example, hyperthyroidism and neurocirculatory asthenia, the prominence of the pulmonic arch may be due to toxic changes or to dynamic dilatation of the pulmonary artery as distinguished from actual organic structural disease. For, with treatment and improvement the left cardiac silhouette again assumes its normal appearance.

It is well known that considerable right heart disease can exist without any apparent roentgenographic alteration. Likewise a healthy heart may assume, either because of "constitutional inferiority or functional deficiency,"[20] the configuration of disease. Német[15] divides these types into two groups: In the first group he places individuals with dropped hearts, as commonly observed among narrow-chested, hyposthenic persons. Here the left cardiac border presents either a small second or pulmonic arc or a broad curve with a marked high standing aortic knob which sometimes fails to reach the left margin of the spine. In this type of heart the enlargement of the conus is more apparent than real. This is due, probably, to the fact that the organ is more centrally situated in relation to the anterior chest wall and also because it is rotated on its vertical axis. Because of the rotation of the heart the pulmonary artery is brought into greater prominence on the roentgenogram. It is possible that this heart represents an earlier type in the phylogenetic scale.[20]

In the second group, he considers the centrally positioned hearts. These are commonly seen in children. Here, one may or may not find an accentuated second or pulmonic arc. In this type, the heart is globular with the aortic curve low, and the remaining curve is formed by the left ventricle. The significance of enlargement of the conus shadow in the roentgenogram in perfectly healthy individuals, to which these two groups belong, is difficult to explain.

A knowledge of the anatomical and histological structures of the conus arteriosus and the proximal portion of the pulmonary artery will enable one to understand why changes in the components of the lesser circulation readily manifest themselves roentgenologically in these regions. The former is a smooth, thin-walled pocket in the apical portion of the right ventricle, free from trabeculations and the muscular projections seen in the remainder of the cavity; the latter may almost be considered as having the structure of a vein. Its wall is thinner than other vessels of the same caliber and its elastic and muscular component of the media, especially along the anterior and lateral walls, is less abundant.[12] Hence this portion of the vessel is so constructed that it will not withstand any increase above its normal pressure. It is interesting to note that Boyd,[5] in his review of the literature of aneurysms of the pulmonary artery, found the trunk to be involved in 90 of 111 cases. With these facts in mind, one appreciates the following: An outpocketing of the conus upon an increase in pressure in the lesser circulation; dynamic as well as organic dilatation of the root of the pulmonary artery; also, because of the histological distribution of the muscular fibers, the structures will of necessity be better visualized in the right anterior oblique position. The improved method of visualization, to be described presently, takes cognizance of the anatomical facts just mentioned.

Before describing the technique which enables better visualization of the conus arteriosus, it is advisable to review roentgenologically the appearance of an accentuated conus and to discuss some of the conditions with which this structure may be confused.

Upon roentgen examination, a full blown mitral heart presents the following features: (1) In the anterior view, there is accentuation of the middle arch on the left side with increase in length and lateral projection. The heart assumes a globular form. (2) In the first or right oblique position, the second arc becomes quite prominent and maintains

a position between the aortic knob above and the auricular appendage or large left auricle below.

Inasmuch as we are dealing with a structure which projects into the left hilum, which in itself may at times present a varied and complex picture, the conus may easily be confused with other diseases. Among

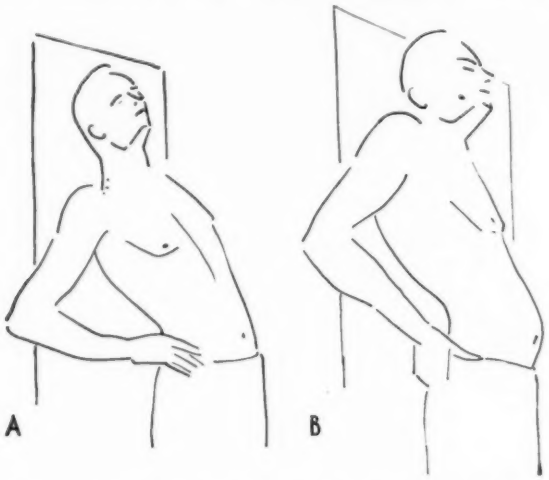

Fig. 1. *A*, lordotic anteroposterior position; *B*, lordotic anteroposterior oblique position.

these are: dilatation of the aorta, a large gland as seen in lymphoblastoma, tumor of the lung, a cold abscess, infection and growths of the mediastinum, dynamic and idiopathic dilatation of the pulmonary artery, a large left auricle and simulated enlargement of the conus as is not uncommonly seen in fibrotic tuberculosis, pneumothorax and atelectasis (conditions associated with displacement and retraction of the heart).[1] Examples of such mistaken diagnoses are shown in Figures 7 and 8.

TECHNIQUE

The procedure to be described is rather simple. It requires high powered equipment because we are dealing with movable organs. The distance employed is standard for chests, i.e., 6 feet, and the exposure time ranges between 1/10 and 1/20 of a second. Ten kilovolts are added. In the oblique view the exposure time is necessarily increased from 1.5 to 2.5 times more. In order to bring out better definition, the films may be slightly overexposed. Central projection is used in all film work so that the ray is at right angles to the amplitude of a wave. It must be emphasized that the amplitude will be exaggerated the farther away it is from the screen.

All cases are roentgenoscoped and roentgenographed in four different positions: (1) posteroanterior; (2) right anterior oblique; (3) lordotic anteroposterior (4) lordotic anterior oblique. The latter may be used between 20–30° (Fig. 1, *A* and *B*).

The lordotic view, seldom mentioned in American literature, has been employed only in the roentgen diagnosis of interlobar effusions. Fleischner[9] and later Wimberger were first to make use of this method. The former mentioned it repeatedly in his classic monograph on interlobar effusions. In this country, Stoloff[18] used this method exclusively among children, for the diagnosis of mediastinal interlobar effusions. Heckmann[11] attempted to demonstrate changes in the pulmonary conus and left auricle by placing the tube high, with the individual in the posteroanterior position, so that the rays would strike this region tangentially. However, his technique not only differs from the one employed here but it also fails to visualize the pulmonic conus in a normal heart. As far as can be determined, no mention is made of the use of the lordotic anterior oblique position in the roentgen examination of either lungs or heart. In these positions the patient is made to assume extreme lordosis by protrusion of the abdomen while the shoulders are held back. Rotation of the patient 20–30° in extreme lordosis will produce the lordotic oblique position (Fig. 1, *A* and *B*).

The positions outlined have definite advantages over the standard methods used in visualizing the conus and pulmonary artery. In the lordotic views the conus region appear more sharply demarcated because its greatest length and depth will be horizontal to and tranversed by the central rays of the tube; also because the conus is brought forward and rotated on its horizontal axis, the rays are perpendicular to

the arc which has the greatest diameter or amplitude; the structures in question will be exaggerated because they are farther away from the screen. Again, because of the peculiar anatomical development and arrangement of the fibers in the wall of the anterior and lateral portions of the pulmonary artery, the greatest dilatation will of necessity take place in this portion of the artery. This is the reason why a better view of this structure is always elicited in the right anterior oblique view. The latter fact together with the information obtained by bringing the conus forward, as seen in

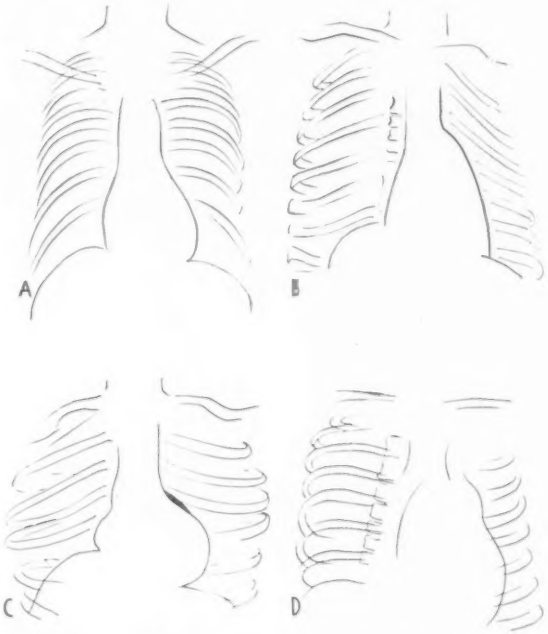

Fig. 2. *A*, posteroanterior view, normal chest; *B*, right anterior oblique view; *C*, lordotic anteroposterior view; *D*, lordotic anteroposterior oblique view.

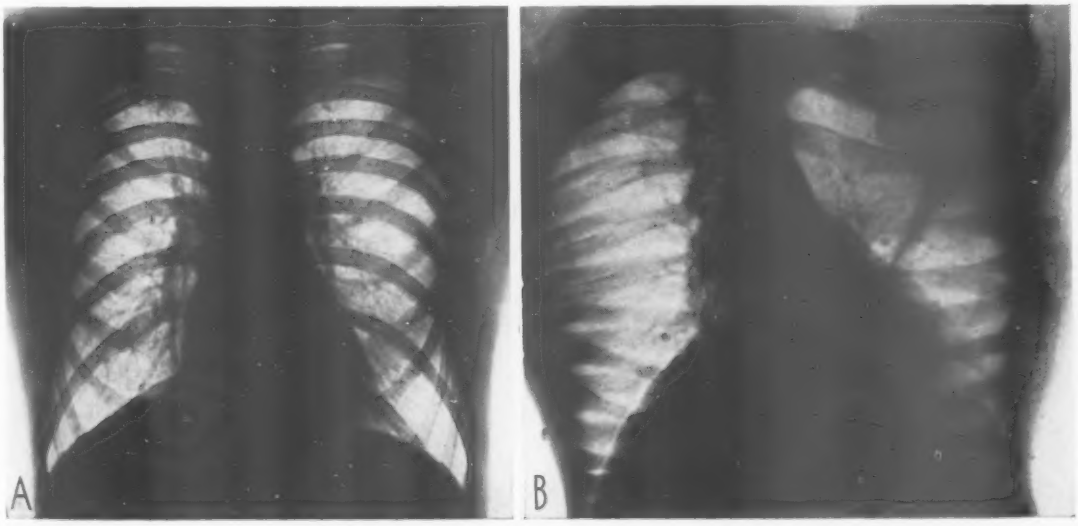

Fig. 3. *A*, normal chest; note absence of conus shadow; *B*, lordotic anteroposterior oblique view. Note normal conus arc.

the two lordotic positions (and therefore in a plane perpendicular to the rays) tend to produce a far better outline of the structures in question (Fig. 2, *A*, *B*, *C* and *D*).

With the standard methods of visualization, a normal heart will not always present a clear shadow of the conus. This may not be necessarily due to the presence of other structures in the left hilum. In the lordotic views however it will be seen as a small outpocketing whose diameter or amplitude could easily be measured. All normal hearts present a conus shadow when observed in the lordotic views (Fig. 3, *A* and *B*).

Figures 4*A*, *B* and C are those of a well established clinical case of mitral heart disease. Here there is no question of accentuation of the conus in the routine films. The lordotic views, however, not only show the structural changes more distinctly and indicate a more pronounced pathologic condition, but they also reveal four distinct curves in the left cardiac silhouette (not visualized by the standard methods). These are, from above downwards: aorta, pulmonic conus, enlarged left auricle and left ventricle.

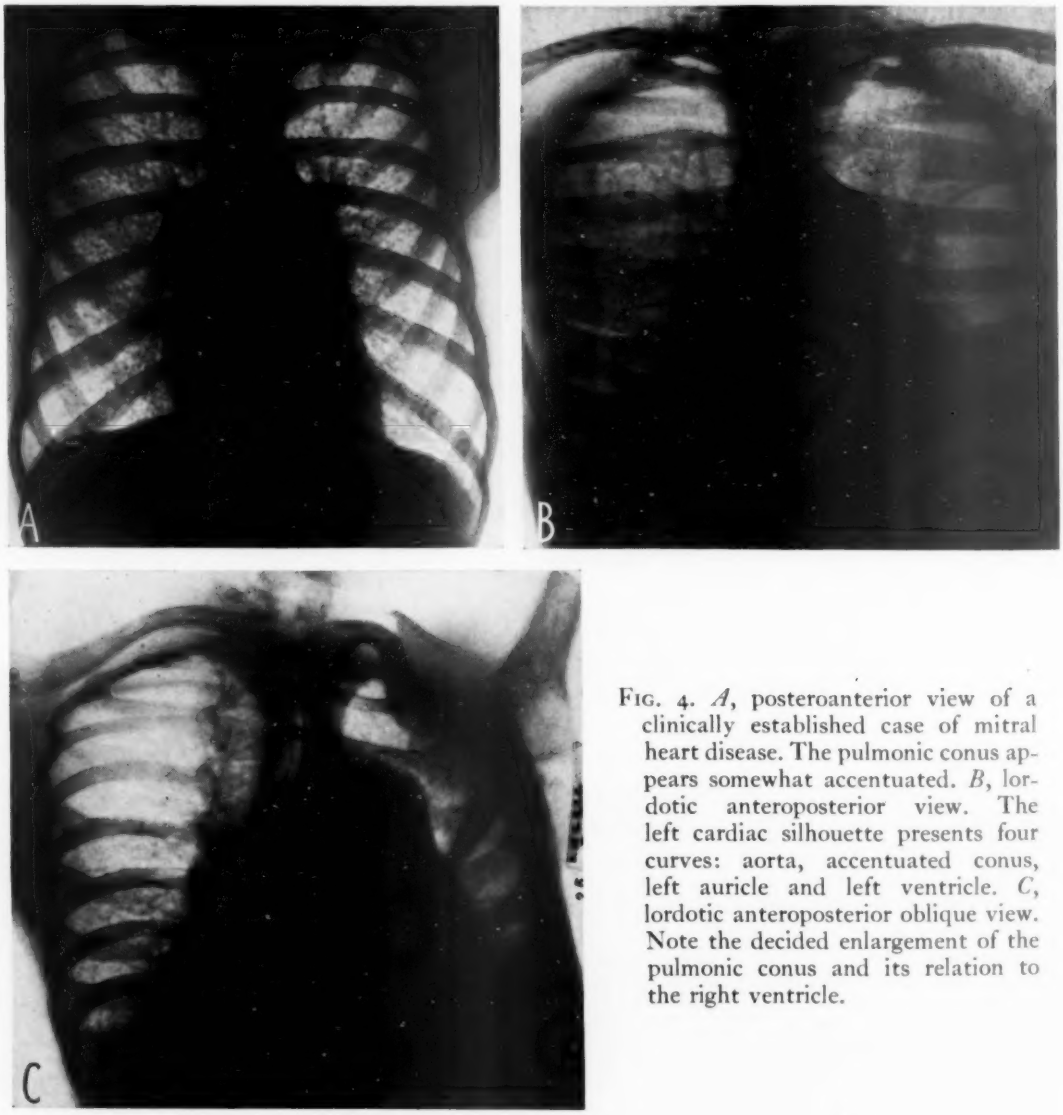

Fig. 4. *A*, posteroanterior view of a clinically established case of mitral heart disease. The pulmonic conus appears somewhat accentuated. *B*, lordotic anteroposterior view. The left cardiac silhouette presents four curves: aorta, accentuated conus, left auricle and left ventricle. *C*, lordotic anteroposterior oblique view. Note the decided enlargement of the pulmonic conus and its relation to the right ventricle.

It is not at all unusual to encounter cases

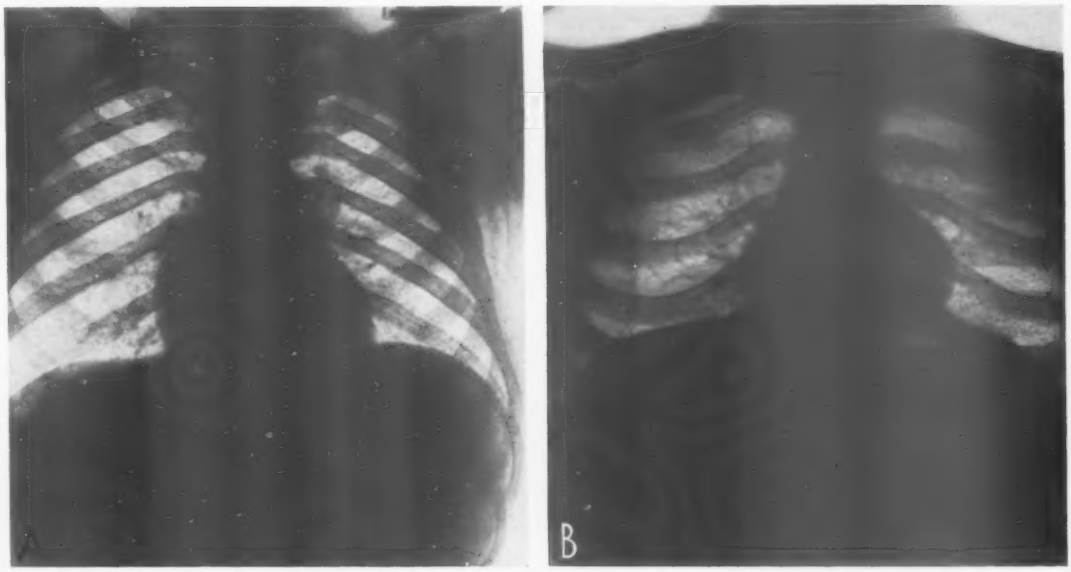

Fig. 5. *A*, posteroanterior view of a questionable case of rheumatic heart disease. The heart is globular and the conus is slightly accentuated. This may be simulated due to the high position of the diaphragms. *B*, lordotic anteroposterior view taken in deep inspiration. The conus stands out distinctly and is accentuated.

in which the presence of mitral stenosis remains doubtful even after the most careful bedside examination. In these cases one often resorts to further aids in the diagnosis, i.e., the roentgen ray and electrocardiagraphy. The latter will only occasionally give helpful indirect evidence of heart disease. The former may show some prominence in the left upper border just below the aortic curve. Should this finding be positive it may still not be indicative of the existence of heart disease, for the mitral configuration may be simulated, either by the individual's habitus or high diaphragms

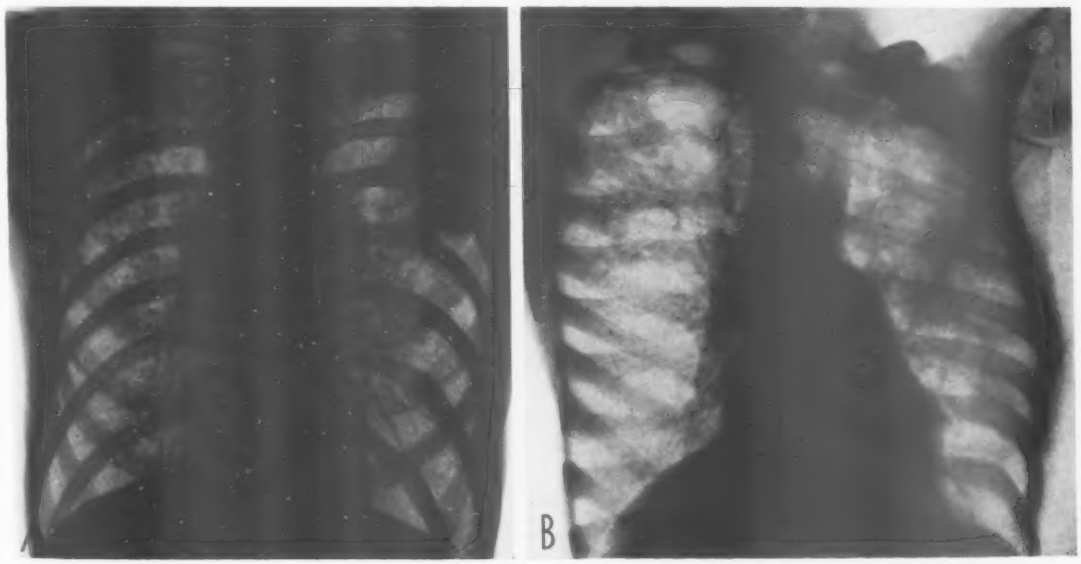

Fig. 6. *A*, pulmonary tuberculosis; hypoplastic heart. The conus is not clearly seen in this view. *B*, lordotic anteroposterior oblique view. Note prominence of conus.

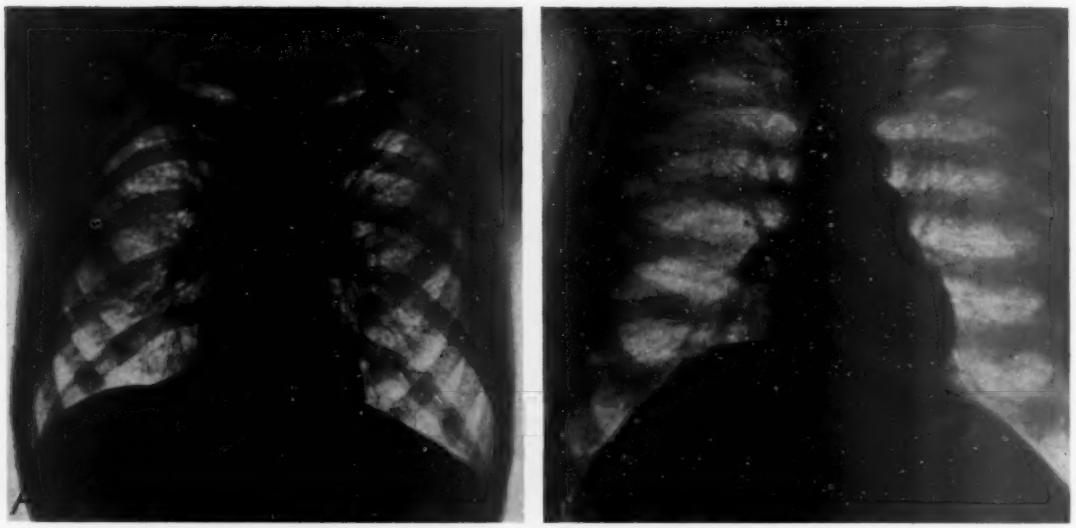

Fig. 7. *A*, posteroanterior view. Pulmonary fibrosis and emphysema. *B*, lordotic anteroposterior view. Note the difference in the appearance of the conus shadow.

as seen in pregnancy, etc. However, when the left cardiac silhouette is seen in extreme lordosis and in deep inspiration, the conus will be decidedly prominent in the presence of organic mitral heart disease, as shown in Figure 5, *A* and *B*. The important thing to realize is that the confirmatory evidence elicited by the lordotic views practically establishes the diagnosis of mitral heart disease.

One of the most common conditions which tends to obscure shadows in the hilar regions is pulmonary tuberculosis (Fig. 6*A*). Here the posteroanterior film merely

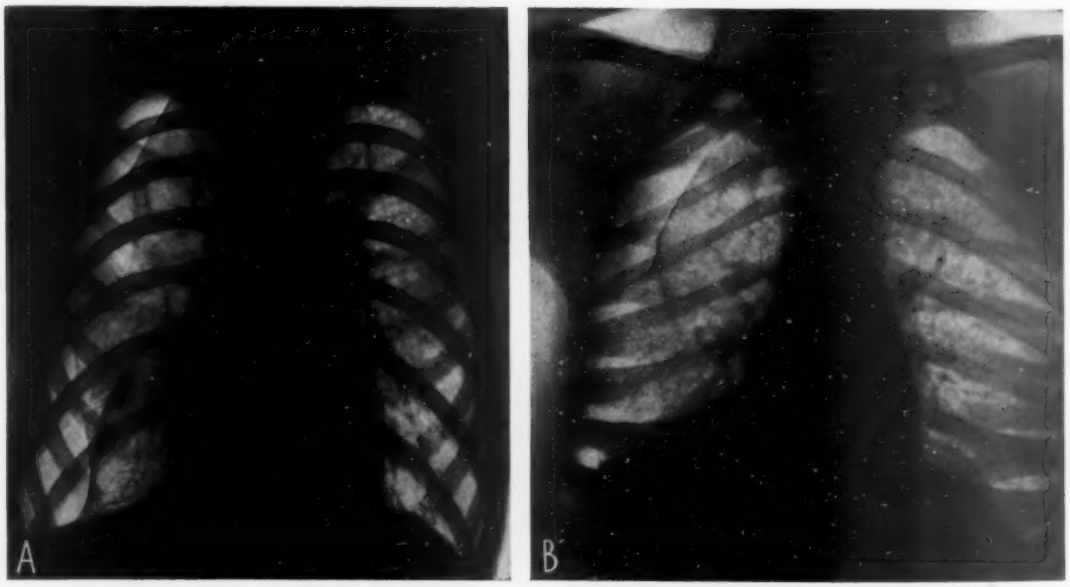

Fig. 8. *A*, posteroanterior view. Pneumothorax with some displacement of the heart. Note the presence of a small second arc which may easily be interpreted as an accentuated pulmonic conus. *B*, lordotic anteroposterior view. This view merely shows two arcs along the left cardiac silhouette and fails to confirm the presence of an accentuated conus.

shows a small outpocketing below the aortic curve. In the lordotic view we see four distinct curves, i.e., from above downwards: aorta, an elliptical shadow formed by a gland, a normal appearing pulmonic conus and the left ventricular curve (Fig. 6*B*). Other diseases such as cold abcesses, pulmonary fibrosis and emphysema (Fig. 9*B*) shows this shadow to be distinct and less dense than the structure of the conus. The lordotic oblique film displays a fairly large circular arc due to the conus and a horizontal elliptical shadow which appears continuous with the conus at its upper pole. This is a clinical case of pulmonary artery aneurysm and with the improved technique

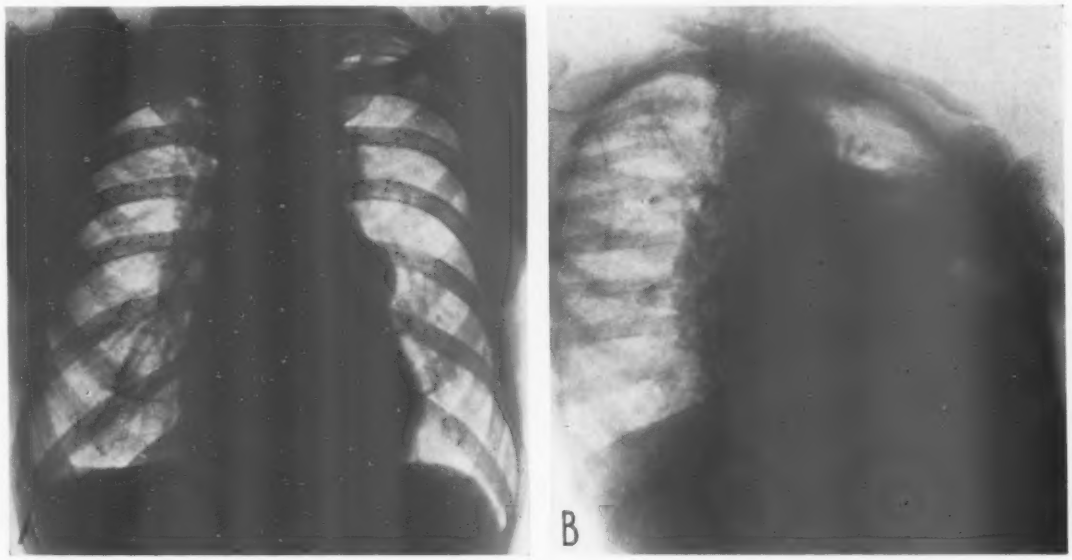

Fig. 9. *A*, posteroanterior view. Elliptical shadow in left hilum which is difficult to interpret in this view. *B*, lordotic anteroposterior oblique view. Elliptical shadow appears quite prominent and is continuous with the conus. Clinical case of aneurysm of the pulmonary artery. (Courtesy of Dr. Tobias Weinberg, Metropolitan Hospital.)

7, *A* and *B*),large glands and lung tumors may very well accentuate or obliterate the pulmonic conus.

Figure 8*A* is a posteroanterior view of a patient with pneumothorax. The second or left middle arc appears somewhat accentuated. The lordotic film (Fig. 8*B*) fails to confirm the prominence of the conus shadow and the lordotic oblique view merely shows a normal conus (Fig. 8*C*). Here we are apparently dealing with simulated enlargement of the conus, due to displacement and probably rotation of the vertical axis of the heart.

Figure 9*A* presents a fairly well circumscribed elliptical shadow which may be variously interpreted from the roentgenological standpoint. The lordotic film (Fig. the roentgen findings tend to substantiate the diagnosis.

COMMENT

It is obvious, from the above cases, that with the technique described, the lordotic views present definite advantages over the standard methods, i.e., posteroanterior and right anterior oblique views, in the roentgen diagnosis of structures in the left hilum and conus regions. These are: the conus can be visualized in all cases; its size can actually be measured and compared with a so-called normal pulmonic conus; it is better isolated from surrounding structures and can therefore be more easily differentiated from other organic changes; it often helps in the diagnosis of a doubtful case of mitral stenosis;

it tends to clear up simulated conditions and, finally, it is an aid in the localization of disease processes.

CONCLUSIONS

1. An improved method of visualization of the pulmonic conus and the pulmonary artery, as well as the left hilum region, is described.

2. That it has definite advantages over the standard methods of visualization is clearly demonstrated.

3. The method is based primarily upon a knowledge of the anatomical and histological structures of the conus arteriosus and proximal portion of the pulmonary artery, as well as upon mechanical changes, namely rotation of the conus on its horizontal axis so that its greatest length and depth will be horizontal to and traversed by the central rays; also upon exaggeration of structures by bringing them farther away from the screen.

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ROENTGENOLOGIC DIAGNOSIS OF ACUTE BRONCHIOLITIS (CAPILLARY BRONCHITIS) IN INFANTS*

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A REVIEW of the clinical and pathological features of bronchiolitis as found in standard textbooks of medicine and pathology shows a rather uniform agreement as concerns these phases of the disease. For example, Kaufmann[4] states that every bronchitis in children or in the aged, whether primary or secondary, shows a tendency to become bronchiolitis and that this is of great importance because the inflammation extends to the pulmonary parenchyma (catarrhal bronchopneumonia) and also because of the easily induced complete obstruction of the small tubules (dyspnea). v. Strümpell[19] in discussing catarrh of the finer bronchi says that simple primary bronchitis rarely extends to the finer bronchi in adults but that bronchitis in children always has a tendency to attack the smaller bronchi, especially in the weak and undernourished. A clear cut description of the clinical features of capillary bronchitis is given by Holt.[3] He states that while in most cases evidence of pneumonia is found at postmortem examination the symptoms are due, chiefly, to a bronchitis which extends to the smallest tubes. These cases are not very common. The onset is acute with fever, rapid and labored breathing, severe cough, moderate prostration, and in most cases cyanosis. The temperature is not high usually only from 100 to 102° F. and often continues so for three or four days. The pulse is rapid and at first full and strong. Respiration is exceedingly rapid, often 80 to 100 per minute. There is marked dyspnea with recession of all the soft parts of the chest during inspiration. Cough is always present, usually severe and sometimes almost incessant. The prostration is not as great as in the common lobular pneumonia of infancy and the development of symptoms is much less rapid. There are at first sibilant and afterwards subcrepitant râles over the entire chest with which are mingled coarser râles. There is no evidence of consolidation. Percussion generally gives exaggerated resonance owing to the emphysema which is present, the note being sometimes tympanitic. Symptoms may gradually increase in severity until death takes place by the third or fourth day from respiratory or cardiac failure. There is usually marked cyanosis and toward the end rapidly increasing prostration. Just before death the temperature often rises to 106 to 107° F. At autopsy, in addition to the pneumonia, the lungs are generally found in a state of hyperinflation and therefore do not collapse on opening the chest. There may be in addition extensive congestion and edema, the development of which has been the immediate cause of death. Those cases which do not prove fatal may show great improvement by the third or fourth day or there may be a continuance of the constitutional symptoms with progress from then on as an ordinary pneumonia.

In Osler's textbook of medicine[13] there is described, as a type of emphysema, the acute vesicular form and it is stated that when death occurs from a bronchitis of the smaller tubes, when strong inspiratory efforts have been made, the lungs are large in volume and the air cells are much distended; that clinically this condition also may occur rapidly in cases of cardiac asthma and angina pectoris. A similar view is held by Norris and Landis.[11] Under the heading of acute vesicular emphysema they state that this condition is a dilatation rather than an emphysema of the air cells, there being no structural change in the alveolar cells; that it is encountered in individuals

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who have died from acute bronchitis of the smaller tubes,or in asphyxia if accompanied by violent expiratory efforts; and also that it may be found in any condition which obstructs the air from entering portions of the lungs thus throwing a strain on the alveoli in other parts.

From these statements and others in the literature it is evident that bronchitis in infants tends to localize in the smaller bronchial tubes and that obstructive phenomena, especially emphysema, are not uncommon.

Concerning the roentgen appearance of the chest in bronchiolitis, Stoloff[18] states that there is widespread involvement of the smaller bronchi and bronchioles which may be completely stenosed or partially obstructed. He makes no mention of emphysema as a roentgenologic feature in this disease and yet there is ample pathological evidence that it is a constant occurrence. Meakins,[8] under the description of acute vesicular emphysema, gives inflammation of the smaller bronchi as one of the chief causes and yet when discussing bronchiolitis makes no mention of emphysema but does describe the presence of atelectasis. Holt, on the other hand, says that the physical signs may indicate a pronounced emphysema. Harrison[2] describes the roentgen appearance of bronchiolitis as numerous small infiltrations due to atelectasis throughout both lungs similar to miliary tuberculosis but lacking the uniformity in size and distribution of the lesions in the latter disease. Rigler[14] gives a somewhat similar description. Wessler and Jaches[20] mention emphysema as occurring in bronchopneumonia but do not describe a capillary bronchitis.

Recently, Snow and Casassa[15] described obstructive emphysema and atelectasis in acute respiratory disease in infants. In a series of 70 cases clinically diagnosed as pneumonia they found varying degrees of atelectasis and emphysema present and demonstrable roentgenologically and pathologically. Areas of atelectasis were more commonly found in the posterior and dependent portions of the lungs while emphysema was more frequent in the anterior parts. They believe that, due to gravity, the secretions tend to plug completely the posterior bronchi with resultant atelectasis while a ball-valve effect with emphysema distal to the obstruction is more likely to occur anteriorly. In some cases, especially in infants under six months of age, the emphysema was so extreme as to cause marked displacement of the heart, rotation of the heart or displacement of the diaphragm. The illustrations accompanying their article show massive areas of emphysema, chiefly unilateral and lobar with corresponding displacement phenomena suggesting ball-valve block of a large bronchus, a picture commonly associated with partial obstruction due to a non-opaque foreign body. In another article[16] they describe a similar appearance as occurring in influenza. Sante, in discussing this latter paper, believed that the emphysema was compensatory rather than obstructive. It is not clear from their first article whether the acute respiratory disease in infants responsible for the emphysema in their cases was a bronchitis, a bronchiolitis, a pneumonia or a combination of these. One is led to believe that any acute respiratory disease in infants where there is associated secretion may produce emphysema or atelectasis, depending upon the completeness of the obstruction, also that the obstruction is likely to be in the larger bronchi.

The following cases are presented to illustrate the clinical and pathological features of acute bronchiolitis together with some roentgenological findings which are believed to be of significance:

CASE 1. (J. S.) The patient was a white infant, aged two months. He was admitted to the Pediatric Service of the State of Wisconsin General Hospital on April 19, 1932. Birth had been normal and the condition immediately after birth apparently was normal. The infant had gained very little in weight and two weeks after birth began to cough and had marked respiratory difficulty which had been present off and on ever since. Accompanying the attacks of respiratory difficulty was a marked cyanosis. Physical examination showed a markedly

undernourished, fairly well developed infant. The respirations were extremely labored, inspirations causing a marked funneling of the lower end of the sternum, and expiration seemed to be prolonged. A moderate degree of cyanosis was present. The temperature on admission was normal. On auscultation over the chest very little air could be heard entering the lungs. On the day following admission to the hospital it was noted that though the respiratory difficulty continued, air could be heard entering and leaving the lungs to a better degree. Percussion and vocal resonance over the chest appeared to be normal with the possibility that there was some emphysema as evidenced by a hyperresonant note on percussion, although this was not definite. The blood count was normal and urinalysis showed no unusual findings. No cause for the marked respiratory difficulty could be found so that a direct laryngoscopic examination was done which was entirely negative for pathology. On the third day after admission the patient began to have fever and rapidly became worse. He died the following day. Roentgen examination of the chest was requested shortly after admission to determine if an enlarged thymus was responsible for the respiratory difficulty. Films in the anteroposterior and lateral directions revealed no evidence of an enlarged thymus or other mediastinal mass. They did show, however, a pronounced bilateral emphysema with greatly depressed and flattened diaphragm, increased space between the heart and sternum and coarse thickening of the trunk markings. The significance of these findings was not recognized at the time since there were no areas of pneumonia demonstrable. On postmortem examination the lungs were found to be voluminous, light yellowish-gray in color and emphysematous throughout. The cut surface showed extreme generalized emphysema, with scattered small islands of red congestion which were not increased in density. Many of the smaller bronchi exuded greenish pus. The hilar structures were normal. Final anatomical diagnosis: Pulmonary emphysema; purulent bronchitis; mediastinal congestion and edema; intestinal distention; hyperplastic celiac lymph nodes.

Fig. 1. Case II. Appearance on the day after admission. Lung fields very radiolucent but not more so than in a normal infant if the film was taken at the height of inspiratory effort. Roentgenoscopy showed absence of deflation on expiration with narrowing of cardiac shadow.

Fig. 2. Case II. Lateral view made at the same time as Figure 1. Note low flattened diaphragm and increase in supramediastinal space.

Case II. (A. C.) This patient, a white male infant, was eight weeks old when admitted to the Pediatric Service of the Hospital on Novem-

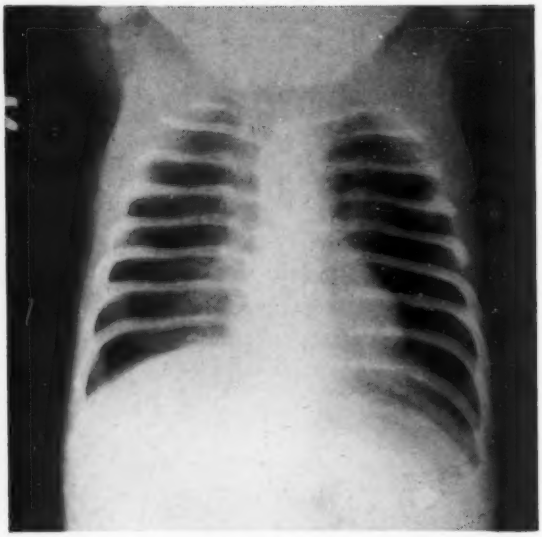

FIG. 3. Case II. Examination three days later. Less evidence of emphysema. Increased prominence of trunk markings.

ber 12, 1936. The onset of the disease had been sudden about twenty-four hours previously with cough and respiratory distress. He had refused several feedings. On examination the baby was very restless. The respirations were fast and labored. The skin was warm and moist. The pharynx was mildly injected. The lungs were hyperresonant throughout and excursion was poor. Fine moist sticky râles were heard bilaterally. The breath sounds were diminished as was the transmission of voice sounds. The temperature on admission was 101.8° F. Examination of the blood showed hemoglobin 40 per cent, red blood cells 3,900,000, and white blood count 12,500 with 38 per cent neutrophiles and 59 per cent lymphocytes. The child was continued on breast feedings and was given steam inhalations. Shortly after admission it was found that the ear drums became somewhat bulging and bilateral myringotomy was done with drainage. Oxygen was given by nasal catheter and small doses of adrenalin were given subcutaneously. The clinical diagnosis at this time was capillary bronchitis. The condition remained unchanged for several days and a transfusion of 60 cc. of blood was given intravenously and 20 cc. of blood intramuscularly. Following this there was a gradual improvement and the patient was discharged on December 8, 1936. Roentgen examination of the chest on November 13 (Figs. 1 and 2) showed both diaphragms to be depressed with both lung fields overaerated and emphysematous in appearance. There was a small area of density at the right base which was thought to be a patch of bronchopneumonia but otherwise no areas of consolidation were seen. On roentgenoscopic examination the same day there was noted a narrowing of the heart during the expiratory phase with very little elevation of the diaphragm. There was no shift of the mediastinum. These changes were considered evidence of an obstructive emphysema suggesting a partial obstruction in the trachea. Examination on November 16 (Fig. 3) revealed some increased thickening of the trunks above the hila and along the cardiac apex but with much less evidence of emphysema. Examination on January 19, 1937, showed a return to normal (Fig. 4).

CASE III. (R. D.) This patient was a white male infant, aged eight months. He was admitted to St. Luke's Hospital, Kansas City, Mo., on August 1, 1937, on the service of Dr. E. L. Glasscock. The patient was said to have had pneumonia the first week in June, 1937, and had been ill about one week. Following this illness the baby seemed to be doing fairly well until about two weeks before admission when he developed a dry hacking cough. This became progressively worse, the baby began to have a diarrhea and to lose weight. On physical examination the skin was pale and there was evi-

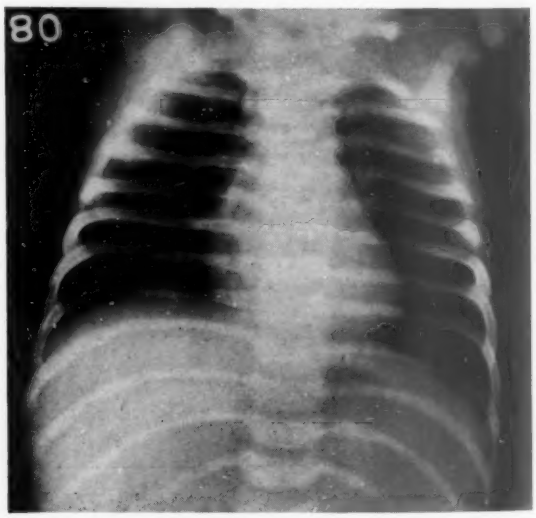

FIG. 4. Case II. Examination two months later after complete clinical recovery. Chest normal at roentgen examination. Compare with Figure 1 at the height of the acute illness.

dence of dehydration. The pharynx was reddened. There were crepitant râles at both lung bases, more so on the right. The abdomen was slightly distended. Nutrition was poor. The temperature on admission was 98.8° F., respirations were 64 per minute and the pulse 146. The white blood count was 25,900 with 84 per cent polymorphonuclear leukocytes and 11 per cent small lymphocytes. Roentgen examination of the chest (Fig. 5) was reported as follows: "Fluoroscopy and a single film of the chest in the anteroposterior direction show a symmetrical bony thorax. The heart is below normal in size, normal in position. Both lung fields are overaerated with depression of the diaphragm and with the diaphragm showing only a slight amount of movement. Respiration is carried on chiefly through the accessory muscles. The right lung field is a little more emphysematous than the left and above the left hilum there is accentuation of the peribronchial trunks. The hilum shadows are within the normal limits of density and show no visible calcification. Conclusions: The process is essentially one of rather pronounced emphysema. This may be secondary to inflammation of the smaller bronchioles, a bronchiolitis, with possible small areas of patchy bronchopneumonia. Roentgenologically, a ball-valve foreign body in the trachea might give a similar picture of bilateral emphysema."

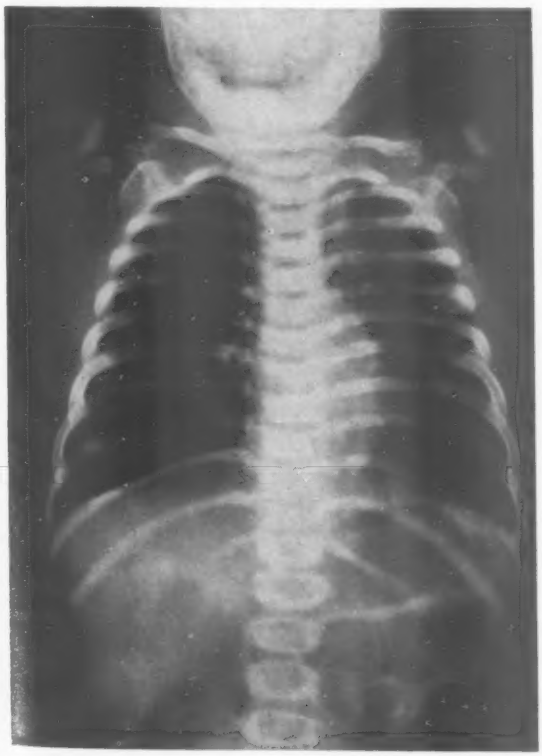

Fig. 5. Case III. Examination at the time of admission. The major changes are those of pronounced emphysema.

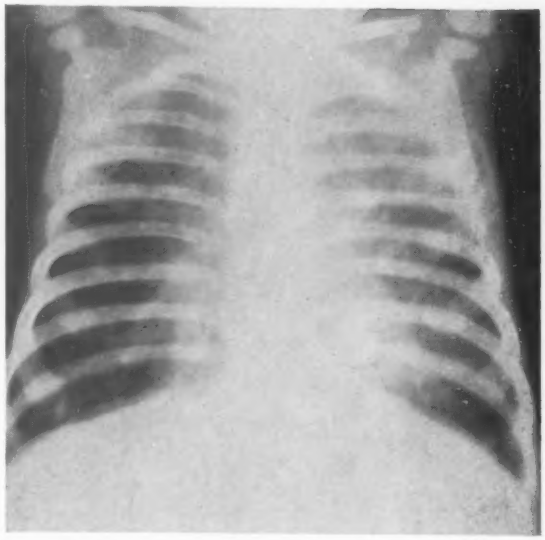

Fig. 6. Case III. Examination four days later. In addition to the emphysema there now is evidence of a patchy and miliary bronchopneumonia especially in the inner and basal lung fields.

A second examination four days later showed a persistence of the emphysema with, in addition, some fine soft mottling at the bases and along the cardiac borders (Fig. 6). These changes were considered as being evidence of a miliary bronchopneumonia. On the day following admission the temperature rose to 105.2° F. and then subsided and maintained a fairly level course around 100 to 102° F. The patient was given two blood transfusions. On the sixth day after admission he looked considerably worse. Râles increased in the chest. The breathing became more labored. Death occurred on the ninth day after admission. A postmortem examination was done by Dr. F. C. Helwig and the findings in the lungs were as follows: "The lungs weigh 120 grams. There are some small patchy consolidated areas and between the visceral and parietal pleura there are some fresh fibrinous adhesions. Section through this shows a small abscess formation. Repeated sections through both lungs show some patchy areas of change and on pressure one is able to cause exudation of purulent material from the smaller bronchioles. The presence of the purulent exudate in the bronchioles exists throughout all portions

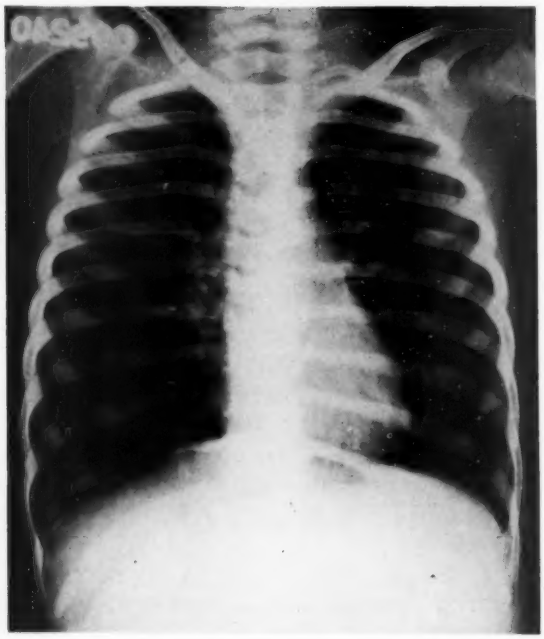

FIG. 7. Case IV. Appearance at the time of admission to the hospital. Bilateral emphysema is the only visible change and this was demonstrated better on roentgenoscopy.

of the lung structure. No gross evidence of tuberculosis could be made out in any portion of the lung tissue. Numerous sections taken throughout the lungs show a more or less similar picture throughout all areas. There are foci of emphysema which is rather marked. There is some thickening of the alveolar stroma. Varying stages of bronchopneumonia are seen in which the exudate is semi-autolytic. In addition to this there are areas where the alveoli are filled with exfoliated epithelial cells or wandering histiocytes. The bronchi and bronchioles are widely dilated and filled with desquamated debris, mucopurulent material and polymorphonuclear leukocytes which are undergoing necrobiosis. Direct smears from the purulent foci at the time of autopsy show the exudate to contain pneumococci and staphylococci. In some areas of the lung the bronchi are so dilated as to almost present the picture of an early or in fact a definitely established bronchiectasis. These bronchi have a thickened wall, and a very intense infiltration with round cells is found in the stroma about the thickened wall." The final diagnosis as concerns the lungs was: Bilateral extensive bronchitis with beginning bronchiectasis; bilateral emphysema with enormous blebs at the left apex; fibrinopurulent pleurisy with encysted purulent pleurisy involving the lung parenchyma on the left; bilateral bronchopneumonia showing varying stages of advancement.

CASE IV. (B. S.) The patient was a white female, aged three, who was admitted to the Pediatric Service of the State of Wisconsin General Hospital on November 25, 1938. Previously she had been a patient here in March, 1938, and was discharged with diagnoses of bronchial asthma, pollinosis, celiac disease and rectal prolapse. Since her dismissal she had shown marked improvement over a period of several months. However, according to the mother, she had never been completely free from colds. One week prior to admission she had an asthmatic attack with a temperature of 101° F. This was followed by earache, and bilateral myringotomy was done. Dyspnea became apparent together with rather severe coughing spells about twice an hour. On admission the temperature was 100° F., the pulse 120 and the respirations 40 per minute. The child appeared ill and coughed frequently. There was a suggestion of peripheral cyanosis. The right ear was draining freely. The lungs were hyperresonant throughout. Medium sized crackling râles, some of which were moist, were heard

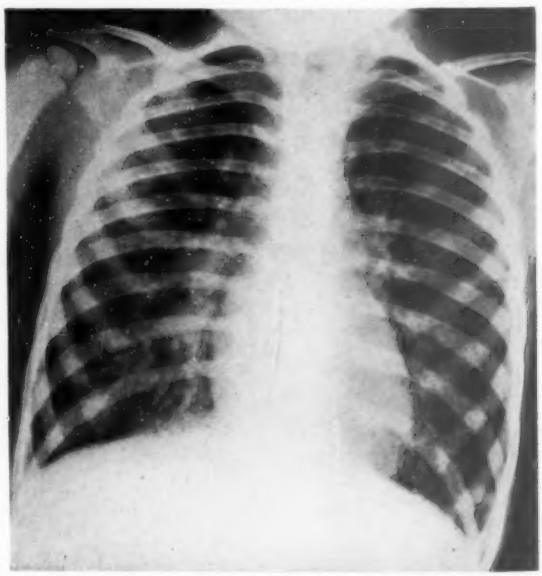

FIG. 8. Case IV. Examination twelve days after Figure 7. There is now evidence of miliary and patchy pneumonia superimposed upon the emphysema.

throughout the chest, somewhat more on the left. There was no bronchial breathing or areas of consolidation. The heart could not be definitely outlined due to the emphysema. The temperature remained around 100° F. until December 3 when there was a gradual rise and she appeared more gray and cyanotic. The chest findings remained about the same. Oxygen was started on November 25. The patient became somewhat confused and irrational, more listless and apathetic. There was some hyperpnea, and the respirations remained rapid. An area of harsh breath sounds appeared in the left upper chest without any percussion change. Death occurred on December 8. Roentgenologic examination on November 25, 1938 (Fig. 7), showed the presence of a well marked emphysema as evidenced by the generally overaerated lung fields, low, almost immobile diaphragm and narrow heart. Respirations were rapid and it was impossible to determine whether or not there was any cardiac narrowing on expiration. An impression was gained of probable acute bronchiolitis. Re-examination on December 2, 1938 (Fig. 8), showed a persistence of the emphysema with the presence of numerous, coarse patchy areas of density in both lungs but especially in the inner zones and toward the bases. It was thought that this represented an extension of the infection with the development of a patchy pneumonia. A third examination on December 7, 1938, showed an extension of the pneumonia. At autopsy the findings in the lungs were as follows: At the right upper lung there was a small band of adhesions which were separated with ease. The lower lobe, especially in the posterior half, was darker and heavier than normal. The bronchi in the major and minor divisions contained a large amount of very heavy, somewhat tenacious, yellowish green purulent material. Cut section revealed marked congestion and edema throughout but especially in the lower lobe. Throughout the posterior half of the lower lobe there were patchy areas of hemorrhage and pneumonia. On the left, the entire lung was darker in color and heavier than normal. The bronchi were similar in appearance to those on the right. The cut section of the lung was in general very moist. The lower lobe was dark red in color and studded with many tiny yellowish points. In the lower portion of the upper lobe there were several small patches of pneumonia (red hepatization). The hilar nodes were enlarged and very soft. The trachea was filled with the same material found in the bronchi. The only other lesion of importance was the finding of a well marked pancreatic fibrosis.

COMMENT

From a roentgenological standpoint the most pronounced change from the normal was a uniform, bilateral emphysema involving all portions of the lungs. The heart was narrow and both diaphragmatic leaves depressed. On roentgenoscopic examination movement of the diaphragm was seen to be practically absent and breathing was carried on chiefly by the accessory muscles of respiration. The overaeration of the lungs stood out clearly, the lung fields being unusually bright in contradistinction to the usual dull contrast ordinarily seen in the lungs of an infant except at the height of deep inspiratory effort. The lungs had the appearance of being in a continual extreme inspiratory state. No shift of the mediastinum was apparent. Roentgenoscopic examination in Case 11 showed a narrowing of the heart at the end of expiration. In the films small patches of pneumonic density could be found close to the hila and at the lung bases, but these areas were few in number and limited in extent, and considering the severity of the illness it was difficult to ascribe the infant's condition entirely to them. Later, after the disease had progressed to a well defined pneumonia, the emphysematous appearance became less marked and numerous small patchy areas of pneumonic density appeared, especially in the medial and basal portions of the lung fields. The miliary character of these was somewhat suggestive of a miliary tuberculosis but the distribution was not as symmetrical and the lesions varied more in size. From postmortem study it is evident that the condition was primarily a purulent bronchiolitis or capillary bronchitis with later development of a miliary pneumonia. It is also evident that much of the severity of the symptoms was due to the emphysema of the acute vesicular type and that this in turn was caused by widespread par-

tial plugging of the bronchioles, giving a diffuse ball-valve effect. In this regard, Morlock[10] makes an interesting confirmatory statement. He contends that when emphysema is seen clinically or roentgenologically, partial bronchial obstruction must be looked for; if the emphysema is generalized and symmetrical then probably the partial obstruction is generalized in the smaller bronchi but may be high up in the bronchial tree above the bifurcation of the trachea.

We agree with Snow and Casassa that obstructive emphysema does occur in acute respiratory disease in infants but we also believe that capillary bronchitis or bronchiolitis is a distinct and well recognized clinical entity and that it produces a definite roentgenologic picture based on well known pathological findings and is not to be confused with ball-valve blocking of a large bronchus with the resulting emphysema of a more localized distribution. The presence of bronchiectasis, as described in Case III, is apparently not unusual since Meakins says that acute bronchiectasis is prone to follow any cause of acute bronchiolitis, bronchopneumonia or peribronchitis.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

In the earlier stages of the disease at least, the most important change which may be expected on roentgenologic examination is emphysema. The roentgen diagnosis of emphysema will not be considered in detail at the present time. Matz,[7] O'Donoghue,[12] Sparks and Wood,[17] and Fray[1] are among those who have contributed to the recent literature on the subject.

Theoretically, any condition affecting the smaller bronchioles and producing a partial obstruction of them might give a similar roentgen picture. Osler describes cardiac asthma and angina pectoris as causative factors in acute vesicular emphysema. These diseases do not occur in infants while, on the other hand, bronchiolitis is rare in adults, except in the aged. Kaufmann mentions asthma as a cause but says that acute alveolar distention occurs more frequently in acute bronchitis in children.

Ball-valve obstruction of the trachea by non-opaque foreign body may give a roentgen picture almost identical with bilateral emphysema. Manges[5,6] has given a description of this condition. According to him a foreign body in the trachea which does not produce sudden death from inspiratory obstruction will invariably cause some degree of obstructive emphysema. If the foreign body remains in the trachea and does not lodge in a bronchus the emphysema will be bilateral. The diaphragm is depressed and shows either a limited movement or a paradoxical one. The heart is narrower on expiration than it is on inspiration and is rotated so that the apex comes forward. This finding of cardiac compression is confirmed by the work of Moore, Wilson and Arbuckle.[9] The patient has severe paroxysmal attacks of coughing especially if the foreign body can move upwards against the glottis. The appearance described by Manges is almost identical with the one we have described except for the small patches of miliary pneumonic or atelectatic density. This similarity is such that in the earlier cases the diagnosis of foreign body in the trachea was entertained from roentgen study alone. Even when a better understanding of the pathological process was at hand we could not absolutely rule out such a lesion from roentgen examination. When the clinical facts are known such an error is less likely to be made. The history of aspiration of a foreign body is frequently obtained. The sudden paroxysmal attacks of coughing and choking are more suggestive of foreign body than of bronchiolitis. The sudden onset of severe respiratory symptoms in a previously healthy infant is always suggestive of foreign body aspiration. If the differentiation is still in doubt, bronchoscopy should be performed. The fact that these two conditions may give such similar roentgen findings is extremely important and one that hitherto has not been recognized.

With the development of a miliary pneumonia, the emphysematous appearance becomes much less noticeable although it can still be seen on roentgenoscopic study.

At this stage confusion with miliary tuberculosis is possible. The lesions, however, lack the uniform size and distribution of those seen in miliary tuberculosis, being more profuse in the medial lung fields and basal portions.

We would also stress the importance of roentgenoscopic study in these cases. Since the emphysema is uniformly bilateral, even a fairly marked degree of it may be present and not be easily recognized on the film. The appearance may closely simulate that seen in a film taken at the height of extreme inspiration as when an infant is crying. The important feature is the absence of normal deflation of the lungs with expiration. It is difficult in these cases to obtain films in both the inspiratory and expiratory phases due to the extreme rapidity of respiration and shallowness of the breathing. In questionable cases the information obtained from roentgenoscopic study is invaluable. To obtain films at the height of inspiration and expiration, Moore *et al.* advocate the use of inhalations of small amounts of a 10 per cent carbon dioxide-oxygen mixture administered through a funnel held close to the nose and mouth.

SUMMARY AND CONCLUSIONS

1. The clinical and pathological features of acute bronchiolitis in infants (capillary bronchitis) are reviewed briefly.

2. The roentgen findings are described. These consist of an extreme degree of bilateral obstructive emphysema simulating the changes seen in cases of ball-valve foreign body in the trachea. This is associated with or followed by the development of a diffuse miliary bronchopneumonia.

3. The importance of roentgenoscopic examination is stressed.

4. Four cases are reported in detail with a correlation of the roentgenologic and pathologic findings in three.

5. Diagnosis and differential diagnosis are discussed.

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VARIATIONS IN THE CALCIFICATION PATTERN IN EPIPHYSES

THEIR NATURE AND SIGNIFICANCE

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RECENT studies have increasingly emphasized the vulnerability of the growing skeleton to metabolic changes produced by endocrine dysfunction. Growth, maturity, and mineral balance are all subject to alteration by changes or abnormality of endocrine secretion. Skeletal appraisal by roentgenograms has become a potent instrument in the diagnostic armamentarium of the physician in cases of suspected endocrine disorders.

Some of the recognized relationships between endocrine function and skeletal growth and form are the retardation in appearance of the secondary centers of ossification in hypothyroidism, osteoporosis and bone cysts in hyperparathyroidism, and delayed epiphyseal union in hypogonadism. Other relationships have been suggested. Druckmann[2] considers Perthes' disease, Osgood-Schlatter's disease, Köhler's disease, and other forms of osteochondritis of polyglandular origin. Zook[7] considers Osgood-Schlatter's disease a result of thyroid deficiency. Köhler[4] has suggested that compact islands in the ends of long bones are a result of lowered gonadal function. Clark[1] has summarized the significance of the roentgen appearance of epiphyses in endocrine diagnosis. Very probably many more features of skeletal form and composition than are yet known to be dependent upon endocrine function actually are so.

In our examinations of the serial roentgenograms of the skeletons taken over a period of years at intervals of one to six months of a group of 220 children, we have become much interested in a developmental phase through which some epiphyses pass. This phase, found occasionally in various epiphyses, is found to a greater or lesser degree in the distal femoral epiphysis of almost every child at one age level or another. This stage of development, familiar to every physician who has occasion to examine the long bone roentgenograms of young children, is shown in Figure 1. Its features are as follows: (1) There is marked roughening and frequently complete loss of the regular outline of the affected area. (2) There is no marked increase in the density of the epiphysis from that present in previous roentgenograms, but areas calcified during the process are definitely irregular in texture. (3) Calcified particles are frequently found beyond the border proper of the epiphysis and may give somewhat the appearance of fragmentation. No real fragmentation of the already deposited bone is present, however. For want of a better term, we shall call the process whose roentgen appearance we have just described disseminated provisional calcification of epiphyseal cartilages, and shall refer to it hereafter as disseminated calcification.

Köhler[4] has called attention to the roughening and peculiar appearance of the distal epiphysis of the femur occurring normally in children between one and three years. We are describing it here because: (1) We wish to emphasize the developmental nature of this phenomena. (2) We have found it to have certain diagnostic significance in indicating the rate of skeletal growth. (3) Our observations suggest that the age at which this growth phenomena occurs and its intensity may be dependent largely upon thyroid activity. (4) We believe that the growth phenomena we have described has, when found in epiphyses other than the distal femoral, been occasionally mistaken for epiphyseal disease.

This disseminated calcification, while it occurs in various epiphyses, is, as we have

FIG. 1. Showing various degrees of and stages in the rapid growth process of the distal femoral epiphysis. *A*, the florid stage of the process in a child with a well-functioning thyroid at two years of age. *B*, the process in a similar case but at thirty months. The florid stage has been passed and the epiphysis has begun the process of re-establishing a regular outline. Both medial and lateral borders of the proximal tibial epiphysis and even the proximal fibular epiphysis show traces of the same disseminated mineralization shown in the femoral epiphysis. *C*, the epiphysis of a child of two years with a lowered metabolism and slow growth processes. The irregularity of outline is very slight, and in this child never became appreciably more marked.

indicated, an almost constant occurrence in the distal epiphysis of the femur, and certainly must, therefore, be considered in this area at least entirely as a developmental process. Besides being at certain age levels a practically constant finding in this epiphysis, it is always most marked and most florid here. We shall therefore confine our discussion principally to this area.

The distal femoral epiphysis appears first in a roentgenogram at from birth to six months after (usually at birth). It is at first somewhat globular in shape with a smooth, well-defined margin of provisionally calcified cartilage or temporary zone of calcification which is, however, not usually more dense than the bone itself. It grows transversely at a much more rapid rate than it does in other directions.

Since the distal femoral epiphysis is the broadest epiphysis in the body, and since the knee joint is one in which structure must develop rapidly if it is to keep pace with the rapidly increasing function during the period when children are becoming more active in the use of their legs, this epiphysis undergoes a period of markedly accelerated growth. In other epiphyses the rate of growth is usually slower, the change from resting cartilage to proliferating cartilage preparatory to provisional mineralization in the areas surrounding the bony center is somewhat leisurely, and the zones of proliferating cartilage and of provisional calcification are relatively shallow. In the distal epiphysis of the femur, the growth is of necessity so rapid in order to keep pace with functional demands, that this orderly process is frequently much disturbed. Acceleration of transverse growth coincident with the fraying out and roughening of the medial aspect of the epiphysis is a constant finding. Roughening and fraying of a lesser degree also occurs on the lateral aspect, but less constantly.

In contrast to most other epiphyses, there is, then, a period of very rapid preparation for ossification, with a transition from resting cartilage into long columns of proliferating cartilage. Since it is the proliferating cells of the epiphyseal cartilage which become calcified (the temporary zone of calcification), there becomes available in this very rapidly proliferating cartilage a very broad, active area in which provisional calcification may occur. The first evidence of the process which can be detected in a roentgenogram is a slight irregularity of the temporary zone of calcification of the epiphysis. The rapidity and unevenness of the proliferation of cartilage cells, plus probable variations in distributions of

blood supply, are responsible for the irregularity and for the frequent complete loss of a well-defined border of the temporary zone of calcification. When the process is very rapid, areas of provisional calcification may appear entirely beyond the border proper of the calcified nucleus. The ragged appearance of the epiphysis as seen in Figure 1*A* is due, therefore, to the very rapid phase of growth through which the epiphysis was passing at the time the roentgenogram was made. The absence of a discrete border and the separated flecks of lime salts frequently found beyond the main border of the epiphysis during the florid stage of the process are the result of the rapid and undiscriminating mineralization of the proliferating portion of the epiphyseal cartilage. The flecks are in reality a part of the usually discrete zone of provisional calcification. The layer of invading osteoblasts progresses rather rapidly from this point on, and as it replaces the provisionally mineralized cartilage a more or less regular outline is again established. The fact that the cartilage has been unevenly mineralized and that the osteoblastic layer moves rather rapidly prevents an entirely smooth contour from forming, however, even after all of the disseminated cartilaginous mineralization has been resorbed. These same factors are probably responsible for a somewhat irregular and moth-eaten appearance of the newly formed bone substance of the epiphysis, which persists for some time. The phenomena, when present to a marked degree, are always bilateral.

INCIDENCE AND FACTORS INFLUENCING THE EXTENT OF DISSEMINATED MINERALIZATION

While the number of children available for this study at the Samuel S. Fels Research Institute is not large (about 220 in all), the opportunity for investigating such factors as age of occurrence, duration, and relationship to growth and maturation of this phase of growth is unusual. The Fels Institute program is a longitudinal study of the growth and development of the group of children already mentioned. Its principal features are regularly spaced examination of a variety of developmental factors from birth to maturity coincident with a study of each child's illnesses, nutrition, and environment, which together provide material for a study of individual differences and their etiology. The material presented here is a part of the 10,000 skeletal roentgenograms, the repeated physical examinations, nutrition records, and a number of basal metabolism determinations which have been collected in this work.

Incidence. This disseminated type of mineralization occurs to some degree in the distal femoral epiphysis of every child in our group. It varies greatly in intensity, however, from mild roughening to calcification that is suggestive of a flocculent precipitate. It occurs next most frequently in the proximal epiphysis of the tibia. If one includes slight degrees of roughening in his count, about 90 per cent of the children showed some slight suggestion of the condition in the lateral aspect of that epiphysis. However, as we have indicated, it is extremely mild in the tibial epiphysis and rarely shows the very ragged appearance so common in the distal femoral epiphysis. Table 1 shows the distribution and severity of the phenomena as they occur in the medial aspect of the distal femoral epiphysis. When roughening of the lateral aspect also occurs, it is always in addition to medial roughening.

We have found it occasionally in the navicular of the foot, in the epiphysis of the calcaneus, in the capitellum, in the distal epiphysis of the tibia, and in other areas.

Age Incidence in the Two Sexes. The age of onset of this ragged appearance varies more in boys than in girls. It also usually appears earlier in girls. Table 1 shows the age of first appearance and degree of intensity in our group of children. Its duration in the group ranges between twelve months and six years. In the majority of children, most of the irregularity is gone two years after its onset. In some cases, however, it may remain in a semi-florid state for four

years or more. It tends to be of shortest duration and most marked in children with rapid general skeletal growth. Its onset tends to be earlier in those children who show advanced appearance of secondary ossification centers throughout the entire skeleton, and later in those in whom ossification centers tend to appear late. The same relationship exists between the age of onset and skeletal age, according to Todd's,[6] and Flory's[3] standards.

The age of onset of the ragged appearance of this epiphysis is usually associated not only with anatomical growth but also with the development of function. Children walking at an early age tend also to develop this ragged appearing, rapid growing stage of the femoral epiphysis earlier than do those beginning to walk later. In our group, the figures for the girls are as follows: Of a total of 11 girls who were walking alone before twelve months of age, 10, or 91 per cent, showed a ragged femoral epiphysis in their twelve months' roentgenograms. Of a total of 39 girls who walked later than twelve months, only 39 per cent showed the ragged epiphysis at twelve months. Of 8 boys who walked alone at or before twelve months, 5, or 62.5 per cent, showed the ragged epiphysis at twelve months, while of 40 boys who walked later than twelve months, 10, or 25 per cent, showed the ragged epiphysis at that age.

Since the epiphyseal phenomenon which we have described is purely a developmental one, one would, of course, expect it to be asymptomatic. Such is without exception the case. We have, however, occasionally seen cases in which this ragged appearance, particularly when it occurred in epiphyses other than the distal femoral, was presumed to be the cause of a limp or pain from some traumatic source. This error may result perhaps from the fact that the disseminated mineralization of the proliferating cartilage, when it is marked, may resemble actual fragmentation of the epiphysis, while at a later stage the newly formed bone may be somewhat irregular in its density and moth-eaten in appearance.

While our opportunity to examine this phenomenon in children who were definitely hypo- or hyper- in thyroid activity has been somewhat limited (consecutive ob-

Table I

AGE DISTRIBUTION AND DEGREES OF DISSEMINATED MINERALIZATION OF THE MEDIAL ASPECTS OF THE DISTAL FEMORAL EPIPHYSIS

Boys						Girls					
Age in Months	No. of Cases	Irregular Outline with Separate Particles per cent	Irregular Outline with Strands per cent	Roughening of Temporary Zone of Calcification per cent	No Irregularity of Epiphyseal Outline per cent	Age in Months	No. of Cases	Irregular Outline with Separate Particles per cent	Irregular Outline with Strands per cent	Roughening of Temporary Zone of Calcification per cent	No Irregularity of Epiphyseal Outline per cent
1	58	0	0	0	100	1	62	0	0	0	100
3	58	0	0	0	100	3	61	0	0	0	100
6	52	2	4	4	90	6	60	2	3	8	87
9	51	2	10	2	86	9	51	0	14	19	67
12	58	6	19	22	53	12	57	11	8	42	39
18	57	8	42	17	33	18	63	33	25	32	10
24	49	16	47	33	4	24	59	17	53	30	0
30	47	15	38	45	2	30	57	7	49	44	0
36	43	5	84	11	0	36	53	0	58	42	0
42	41	5	50	45	0	42	51	0	39	61	0
48	38	0	52	48	0	48	43	0	30	63	7
54	33	3	21	73	3	54	32	0	18	34	48
60	33	3	9	79	9	60	33	0	15	18	67
66	22	0	9	31	60	66	14	0	21	7	72
72	23	0	0	8	92	72	22	0	0	5	95

servations on 46 of these children), and has been inadequate for the presentation of reliable statistics on the subject, we believe we have observed certain relationships which are helpful in evaluating thyroid function. Pierson,[5] in discussing a paper by Elward, states that hypothyroidism is responsible for a granular appearance of epiphyses which he says, "closely resembles epiphysitis." Our own observations are as follows:

1. Children with low thyroid activity develop the ragged appearance of the femoral epiphysis much later than do children with normal function. While 67 per cent of boys and 90 per cent of girls in our group showed the process to have begun by eighteen months, mildly hypothyroid children usually do not begin until thirty months, and marked hypothyroids not until much later.

2. If thyroid function remains depressed, the cauliflower-like appearance does not become marked and the process may be limited to roughening.

3. A child with a well-functioning thyroid will show an early appearance of the cauliflower-like epiphysis (between nine and eighteen months).

4. An acceleration of thyroid function either in a child with normal function or in a hypothyroid child will produce marked cauliflower-like appearance of the femoral epiphysis, but this change will appear at twelve to eighteen months in the normal case, and at three or four years in the hypothyroid child in which thyroid function is improving.

Roughening in other epiphyses may accompany an increase in thyroid function above its previous level.

SUMMARY

A period of very rapid growth, particularly in the broader epiphyses of the skeleton, often produces a ragged appearance. Calcified areas may appear completely detached from the bony nuclei. A greater or lesser degree of the appearance is an almost constant finding in the distal femoral epiphysis and a mild degree of it is a not infrequent finding in the proximal tibial epiphysis. The ragged appearance is due to a period of very rapid epiphyseal growth which is usually a part of very rapid general skeletal growth. It is entirely a maturational and growth factor. Its earliest appearance in any of our children was at about nine months. It is variable in its duration. It is asymptomatic. We believe that the maturational change we have described here has occasionally, when occurring in epiphyses other than the distal femoral, been called epiphysitis and been considered a pathological process. We believe that the age at which the process occurs and the degree of its floridity are influenced by thyroid function and changes in thyroid function.

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BRACHYDACTYLY, POLYPHALANGISM, AND BRACHYMETAPODISM IN A MORONIC INDIVIDUAL WITH MICROCEPHALY, INTERNAL FRONTAL HYPEROSTOSIS, AND ENDOGENOUS OBESITY*

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RECENTLY a description of the various congenital, hereditary, and constitutional deformities to be observed in the human hand has been issued in monographic form.[10] So many and diverse are the recorded conditions that codification has been difficult. Müller[10] suggests that each case is as a stone in a mosaic, comprehensible only when seen in relation to the whole. Many blocks of the pattern are still missing. Every new case is another piece to be arranged in the design only by the closest scrutiny of the personal and familial background.[6,10,11,13] Finally, the whole can be reconstructed when sufficient fragments have been fitted together to show the fundamental etiologic, developmental, and anatomical factors common to the group.

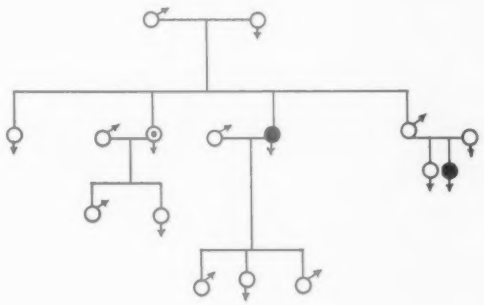
To carry the metaphor further, the patient described below is as a multifaceted stone, difficult to place, but, once adapted, capable of illuminating the entirety. She possesses a combination of several of the anomalies of the hand, which have been separated from one another as distinct entities.[4,6,10,11,13] Moreover, the rarity of the changes seen in her digits has been emphasized by Lossen[7] who, in 1937, could find but 11 such cases, involving eight families. The probable familial, endocrinologic, or recessive nature of her complaints is further stressed by the presence of mild microcephaly, mental deficiency, internal frontal hyperostosis, and endogenous obesity.

CASE REPORT

M.L., female, married, aged forty, states that she "was born with small hands and feet," and that their unusual appearance was then present. She left school at the age of sixteen while still in the fourth grammar grade. She has had no significant illnesses. Her catamenia was established at the age of thirteen, recurs at twenty-eight day intervals, and until three years ago, when the flow became scanty lasting but one day, she had been accustomed to have a moderate discharge of from three to four days' duration. Within the past four years she has gained in weight from 127 to 187 pounds, has developed hairiness of the chin only, and has been treated for high blood pressure. There are two children, eight and twelve years old respectively, neither of whom has shown any physical deformities. A very obese sister and a brother's daughter show a deformity similar to that of the patient (Chart 1).

CHART I

GENEALOGY



◉ Patient

● Similarly affected relatives

Physical examination reveals a woman appearing older than her stated age, weighing 187 pounds, of "hypopituitary" habitus, 61 inches tall, 56 inches in span, and 25 inches from pubis to the floor (Figs. 1, 2 and 3). The shape of the head suggests a slight degree of microcephaly. Moderate dorsal kyphosis is present. Her obesity is of the girdle type and affects the distal portions of the extremities less than the proximal. The heart is moderately enlarged

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and the blood pressure 178/90. Both hands (Fig. 4) are small, and show symmetrical variations from the normal. All the fingers are short, but this is most noticeable bilaterally in the second, third, and first in the order named. Neither the index nor middle finger is as long as the little finger. Both present a definite abnormal ulnar deviation. The distal phalanx of the fifth finger is the only one having an inclination towards the radial side of the hand. Roentgenologic study demonstrates (Fig. 5):

1. Abnormal shortening of the first, fourth and fifth metacarpal bones.

2. Enlargement of the base of the first phalanx of both index fingers with radial displacement. On the right side this digit has the appearance of a metacarpal bone.

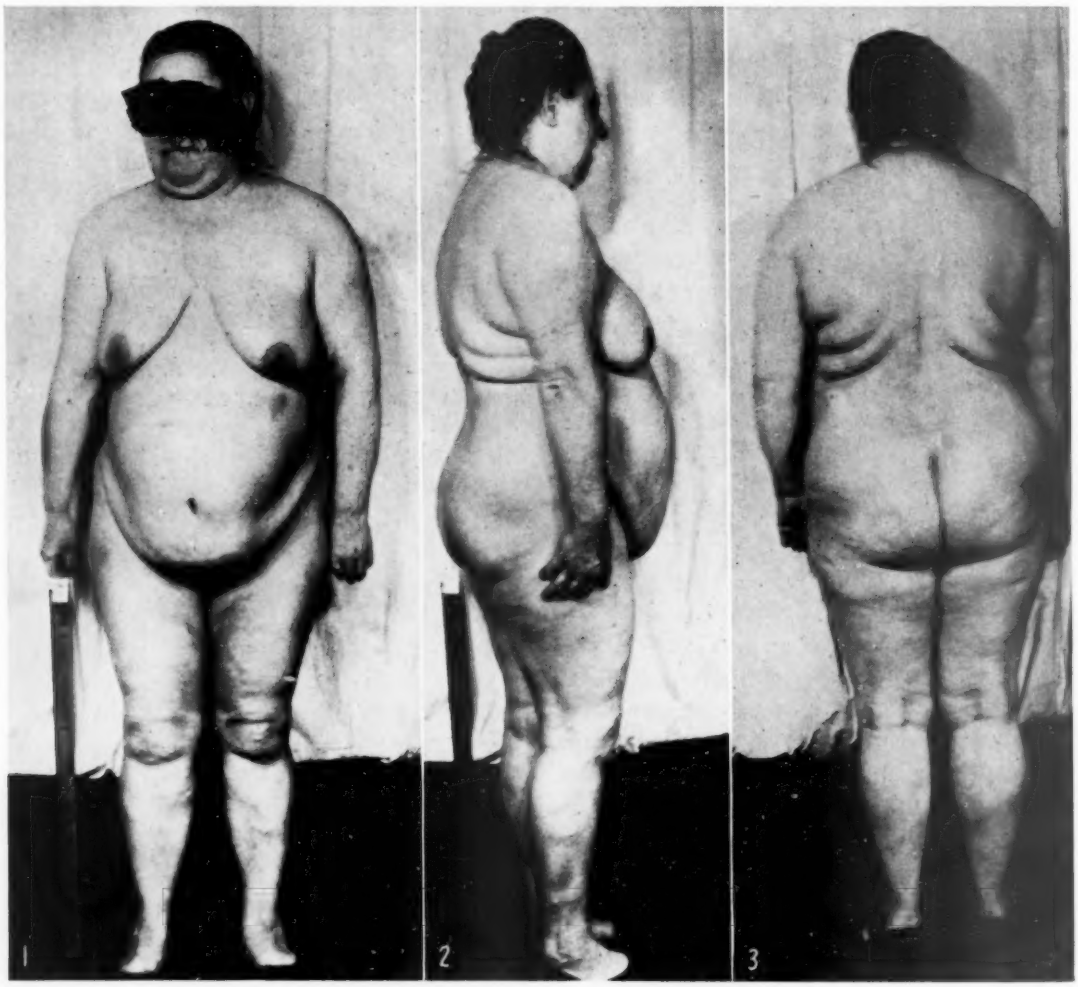
3. Shortening and broadening of the basal phalanges of the middle fingers and of the left index finger.

4. Polyphalangism of both middle and of the left index fingers, with the interpolation of a short, broad bone between the proximal and middle phalanges in each instance.

5. Marked shortening of the middle phalanges of all fingers.

6. An ulnar deviation of the bones of the index and middle fingers, and a radial deviation of the last phalanx of the little fingers.

When the changes observed roentgenologically are translated into actual measurements (Table 1), the absolute and relative values become even more significant. The relatively great shortening of the metacarpal of the



FIGS. 1, 2 and 3. Patient M. L. Note short stature, girdle obesity, relatively small hands and feet, slight kyphosis, and genu varum.

Fig. 4. Hands: Note bilaterally symmetrical deformities with second and third digits shorter than the already shortened little finger.

thumb, maintenance of normal length in the distal phalanges, the comparatively short fifth metacarpals, and the altered measurements in all middle phalanges demand recognition.

The feet are small as compared with the legs (Fig. 6). The toes are very short and show no

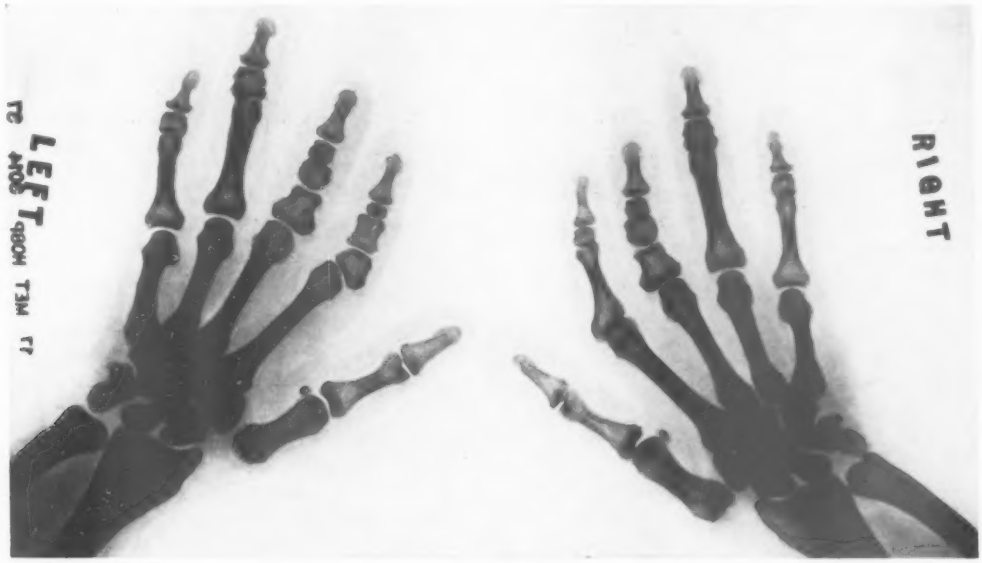


Fig. 5. Roentgenogram of hands. Abnormal shortening of fourth and fifth metacarpals; metacarpal-like right basal phalanx index finger; ulnar deviation of second and third digits; interpolated bones in three digits; and shortened middle phalanges in second and fifth fingers.

FIG. 6. Feet with shortened toes.

other gross change. This is confirmed by roentgenograms in which the middle phalanges of the second, third, and fourth toes are observed to be exceedingly short and broad (Fig. 7). The middle phalanx of both little toes is missing, and the base of the distal segment is broadened.

Laboratory procedures performed with a normal result have been: sedimentation rate; blood chemical constituents including calcium, glucose, non-protein nitrogen, creatinine, cholesterol and esters, proteins, and phosphatase; complete blood count; and electrocardiogram. The urine has contained a very faint trace of albumin, and produced a "very slight reduction" of a copper solution. The blood Wassermann reaction was negative. The basal meta-

TABLE I

MEASUREMENTS (IN MILLIMETERS) OF ROENTGEN SHADOWS OF METACARPALS AND PHALANGES

	Part	Metacarpals		Basal Phalanx		Middle Phalanx		Supernumerary Phalanx		Distal Phalanx	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
	Thumb	31	29	26	26	—	—	—	—	19	19
Fingers	Index	53	53	31	11	6	11	—	4	17	17
	Middle	49	49	13	13	9	7	7	7	17	17
	Ring	45	43	38	37	9	9	—	—	16	16
	Little	35	35	28	28	6	6	—	—	13	13

bolic rate was plus 2 per cent. Blood sugars taken before and at one-half hourly intervals following the ingestion of 100 gm. of glucose have shown 86, 130, 137, 167, 164, and 120 mg. per 100 cc. respectively.

Roentgenograms of the spine and other long bones have revealed no anomalies. The skull contains a normal sella turcica. A wavy, irregular thickening of the inner table of the frontal bone is noted, more marked on the right than on the left side, and from before backward (Fig. 8 *A* and *B*).

FIG. 7. Roentgenogram of feet. Bilateral shortening of middle phalanx of second to fourth digits, and absence of corresponding member of the fifth toes.

DISCUSSION

Three degrees of maldevelopment of the hand may be recognized[3]: (*a*) those deformities which are believed to result from abnormally laid down skeletal anlages; (*b*) disturbances due to failure in full development of the primitive hand plate in which the preceding stages have been normal; and (*c*) those abnormalities which appear in the evolution of the hand from an apparently normal primitive stage.

The striking feature in the case described is the presence of the brachydactylic triad —brachymesophalangism, hyperphalangism, and shortening of the first metacarpal bone. This is, indeed, a rare combination despite the fact that many instances of the condition may have gone unreported, as would be suggested by realizing that brachydactyly alone has been recorded in over 100 instances.[2] In 8 cases summarized by Lossen,[7] the lesions were bilaterally symmetrical—"mirror picture." In the other 3, to which the present case may be added, the alterations differed in the two hands.

The common denominator of the group rests in the shortening and broadening of the proximal and middle phalanges of the second and third fingers, and, in 10 of 11 instances, in the interpolation of at least one additional phalanx. However, it would appear that no two patients present identical deformities. In the 3 children of the group supernumerary epiphyses (2 cases) and absence of normally appearing epiphyses (2 cases) have been seen. In one of these the supernumerary epiphyses were present in the first and second metacarpals with absence of the epiphyses of the proximal phalanx of the second, third, and fifth fingers.

Incomplete longitudinal bony division, or "notching" of the proximal and middle phalanges has been seen in 2 patients, in one instance involving the second, and in the other, the third finger. It would seem that the present case merely represents a higher degree of disturbance in the formation of the anlage than do the other reported instances occurring in the same general group.

Supernumerary phalanges have been seen in the second and third digits only. In Leboucq's[10] report, this was recorded for these fingers on both hands. In one of Joachimsthal's cases,[5] they were noted in both fingers of the right hand and in the index digit of the left. The anomaly is present in three digits in the individual here described, viz., the second and third on the left, and the third on the right. She thus varies from Joachimstahl's patient only in the distribution of the anomaly. However, the basal and middle phalanges of the first finger of both hands in his subject showed also a partial longitudinal separation of the bones. This would suggest that supernumerary digits and supernumerary phalanges may arise as a result of similar inbred hereditary traits. They are perhaps not so distinctly separable as arbitrary classification might imply. Joachimsthal[5] has already emphasized this point in a study of several generations of a single family. On the other hand, it is equally true that a single recessive trait has been seen con-

FIG. 8. *A*, posteroanterior view of skull, showing wavy thickened appearance of internal table; *B*, lateral appearance of skull showing changes in the frontal bone already described in *A*.

stantly in succeeding generations of a family, e.g., brachydactyly,[4] klinodactyly,[15] hyperphalangism.[14]

The present patient offers no exception to the remarkable fact that in brachymesophalangism and polyphalangism, the nail or distal phalanx is always perfectly normal.

From Table 1 it can be observed that the ratio of the length of the first metacarpal to that of the average of the lengths of the other metacarpals is as 1:1.5. Lossen[7] found the ratio as low as 1:1.9. These figures contrast with the normal relationship of approximately 1:1.3. Cohn[3] accounts for the normal relative shortening of the first metacarpal by considering it embryologically as a third phalanx, corresponding to the basal phalanges of the other fingers. Such a conception affords an easy explanation for the still further shortening observed in the group of cases under discussion.

The metacarpals of the ring and little fingers of both hands are shortened (Table 1). The difference in the appearance of the corresponding digits (Fig. 4) is due to the disproportionately lengthened basal phalanx of the fourth finger. Müller[10] treats brachymetapodism, a deformity most frequently involving the fourth and fifth digits, as a separate entity. He believes it is due to an absence or deficiency of the epiphyses and represents a milder degree of growth disturbance, or perhaps a disturbance at a later developmental period than that associated with the phalangeal deformities which have been previously described. Its bilaterally symmetrical distribution, as in this case, is the exception rather than the rule.

Internal frontal hyperostosis (Fig. 7) is believed to be present in 40 per cent of all women who are in or beyond the menopause.[8] Its appearance in the present instance in the premenopausal years in association with alterations in menses and in general bodily build may be the result of an endocrinous imbalance which had its origin in her developmental period along with other recessive traits. Lossen[7] comments that "since the endocrine glands may cause abnormalities of the new growth of the bones, then it seems possible that the whole matter of polyphalangism, brachydactyly, and so forth is a germ plasm disturbance."

Inspection of the family tree (Chart 1) in the present instance leaves little doubt as to the hereditary nature of the anomalies and suggests their recessive character.[1,12] In the opinion of Bagg[1] and Stockard,[12] the nature and degree of the deformity is merely an index of the moment in development at which an arrest took place. That one single defect should appear in successive generations of the same family merely speaks for the hereditary transmission of a single factor or group of factors capable of interrupting development at a specific time. The effects of inbreeding are shown by the experiments of Bagg[1] and by the rather tragic case reported by Mohr and Wriedt[9] in which a marriage between individuals with brachyphalangism was followed by the birth of one child with the same deformities, and of a second who lived but one year as a result of widespread malformation, including the manual changes found in the parents.

Infectious diseases, such as syphilis, tuberculosis, cardiac conditions, excesses of all kinds, including addiction to alcohol, opium, cocaine, and so forth, may be among the original influences damaging the constitution of the individuals in whose offspring these recessive traits are destined to appear.[7]

In conclusion, it appears that the deformities to be observed in any individual case depend not so much upon the nature of the exciting cause as upon the time in fetal development at which it acts.

SUMMARY

1. A female patient is described in whom multiple hereditary skeletal deformities are associated with mental deficiency, microcephaly, internal frontal hyperostosis, and endogenous obesity.

2. The bony changes include brachy-

dactyly, hyperphalangism, and brachymetapodism of the hands; and brachydactyly, and hypophalangism of the feet.

3. A survey of three generations of the family reveals the presence of similar disturbances in the hands of a sister and a niece.

4. The deformities in this case and those already found in the literature are compared.

5. Growth arrest at a particular time in somatic development is emphasized as the underlying hereditary trait in this and similar conditions.

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ROENTGENOLOGICAL STUDIES OF THE MUCOSA OF THE NORMAL TERMINAL ILEUM*

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THE roentgenological examination of the gastrointestinal tract has focused its interest on the mucosa, especially during the last years. Following Forssell's work on autoplastic movements of the mucosa, many authors have studied the esophagus, stomach and large intestine. The difficulty in studying the small intestine is so great that only very few findings have been published. Since Crohn, Ginzburg and Oppenheimer[4] reported their cases of regional ileitis, the terminal ileum has been of special interest to the gastroenterologist. Many cases of this disease have been published since, but all these reports deal with advanced findings, in which, for instance, the string sign[7] or similar ones have been presented. Apparently this disease is not as rare as it was considered to be after the first cases were published. It would be of great value if we could detect pathological conditions of this region of the ileum in earlier stages. We therefore have endeavored to find the roentgenological aspect of the *normal* terminal ileum in order to be able to compare it with *early* pathological lesions in the ileocecal region.

The normal terminal ileum has not yet been very widely studied. Only rarely do we find reference to it in some textbooks (Becker and Oppenheimer;[2] Golden;[6] Maingot, Sarasin and Duclos;[9] Chaoul and Adam[3]).

TECHNIQUE

To study the mucosa of the terminal ileum, three ways are possible by administration of barium:

(1) Orally.
(2) By enema.
(3) Studying a specimen after autopsy, covering the mucosa by a thin layer of contrast substance.

If we study the mucosa during life by the first two methods, we always face the great difficulty of determining whether the last ileal loop is filled by contrast substance alone, or whether fecal particles are present in addition. Therefore folds or fold-like markings are the principal factors that should be used for its identification. We know, for instance, from Bársony and Koppenstein,[1] that foreign bodies, like peas, grapes or fruit pits, accumulating in the last ileal loop, give the roentgenological signs of a tumor. The diagnosis in their case was only rectified after operation. We therefore advise basing the diagnosis on careful detailed studies of the mucosa and emphasize critical re-examination before definitely establishing the presence of a lesion.

If we select the oral method for our examination, we are always able to demonstrate the terminal ileum from three to eight hours after the administration of the contrast substance.

If we select the rectal, the terminal ileum can be demonstrated only if the ileocecal valve is patent. A patent ileocecal valve was found in only 60–70 per cent of our cases. Very often the ileocecal valve opens only after the patient has tried to defecate.

For the study of our cases, we used a spot film outfit with a cone about 8 cm. long. This attachment allows us to push disturbing loops of the intestines aside so that on the films the desired loop is distinctly visible without overlapping. Besides, with this cone we are able to compress the abdomen. This is very important in patients with protruding abdomen. We first localize the loop of the ileum roentgenoscopically, set our cassette in place and switch the roentgen machine immediately to roentgenography. As our cassettes are translucent, we

From the Gastro-Enterological Clinic of the Lenox Hill Hospital.

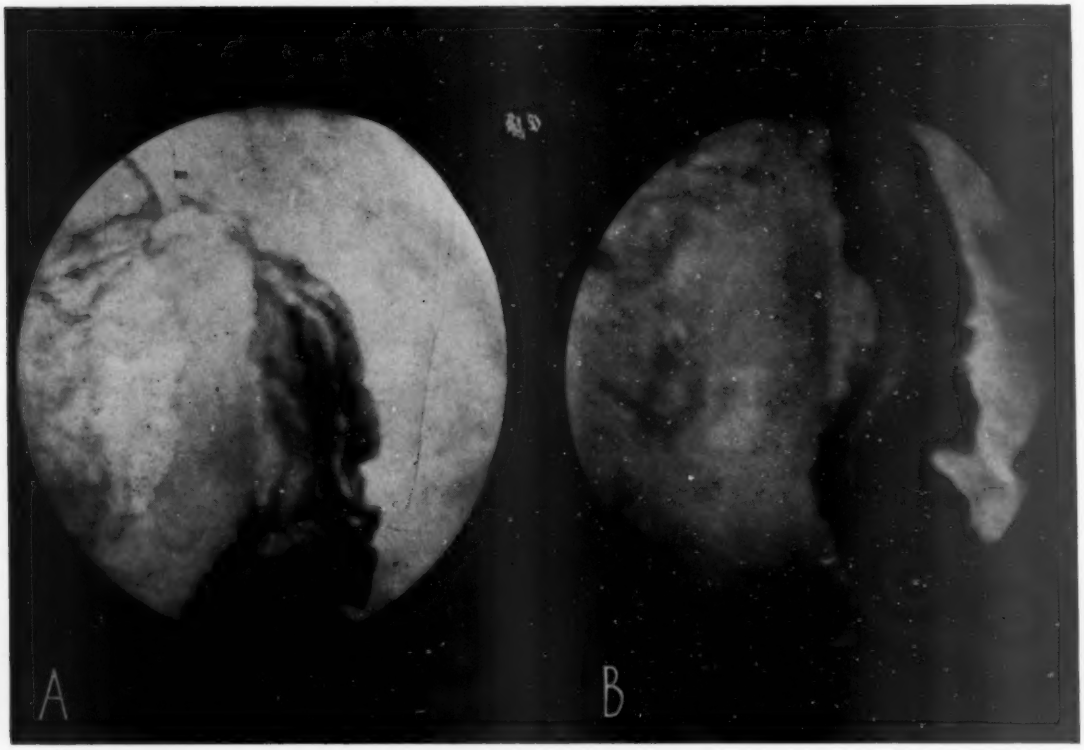

FIG. 1, *A* and *B*. Normal mucosal pattern of the terminal ileum. Films are taken under different amount of compression. Note the longitudinal folds in the ileum, especially at the ileocecal junction and the different peristaltic waves in the prececal loop of the ileum.

are able to see the spot on the fluoroscopic screen which we wish to roentgenograph without any difficulty.

The amount of pressure which has to be exerted to visualize the mucosa varies greatly. In patients with strong abdominal muscles we have to exert a considerable amount of pressure. Considerable pressure is likewise necessary if the patient is examined when there is active peristalsis in the terminal ileum. Because of this observation it became necessary to determine whether the amount of the pressure exerted during the examination had an influence on the mucosal pattern.

The technique of studying mucosal folds of postmortem specimens consisted in covering the surface of the specimen with a thin layer of barium. It is very important to refrain from stretching or damaging the specimen, for otherwise it interferes with visualization of the mucosal markings. The specimens were rinsed carefully after removal and examined about thirty minutes after autopsy. It is important to lose as little time as possible between the autopsy and the examination, as a natural loss of tonus increases the already existing difficulty in this type of examination. We think that the poor results of some workers in this field were due to the fact that the roentgenological examination was performed too long after autopsy.

EXPERIMENTAL STUDIES

The mucosa of the terminal ileum is simple in its outline. The folds are of about the thickness of straw. They are, in their basic appearance, parallel and mostly longitudinal. The small intestines are thin walled and stretch easily, therefore the pattern of their mucosa is readily changed by any outside influence. The folds themselves should have a clearcut contour. The contrast sub-

stance is visible in the crevices of the mucosa, whereas the folds themselves stand out clearly without being covered by barium. The folds converge towards the ileocecal junction. As it was important to know how far pressure would interfere with the mucosal pattern, a series of roentgenograms were taken under varying amounts of pressure (Figs. 1 and 2) and in different stages of the peristalsis. The basic pattern is the same. The thickness of the folds and their arrangement does not change much under procedure. The ileocecal valve is open in Figure 2 *A* and *B* so that the converging of the prececal sphincter is closed. Some of the areas without contrast substance are clearly due to fecal contents in the loop.

Further studies of the terminal ileum dealt with the *type of filling* of this loop. We had cases in which the head of the barium column just reached the prececal ileum during examination. The barium was in the convolution of the ileum in the pelvis (Fig. 3 *A*). The last loop, serpentine like, rose from this convolution upwards and laterally. The loops of the pelvic ileum showed a transverse arrangement of their folds. These folds were mostly parallel and had the same quality as previously reported. In the prececal loop, the folds show a longitudinal arrangement (Fig. 3). The filling does not take place in a mass movement but gradually; the contrast substance slowly trickles along the crevices of the gut. The folds have a wavy appearance and we see creeping movements. This is demonstrated, too, by the wavy outline of their contours visualized during this type of movement. These waves are shallow and usually occur only on one curvature at a time, either on the inner or outer curvature.

The second type of the transport of the contrast substance is seen later. At that time the cecum is already partially filled. Now the bulk of the barium is continuously transported through the ileum into the cecum. The ileal contractions occur ring-like in two places simultaneously, about 2 to 5 cm. apart. These two contractions travel in a caudal direction, keeping the distance

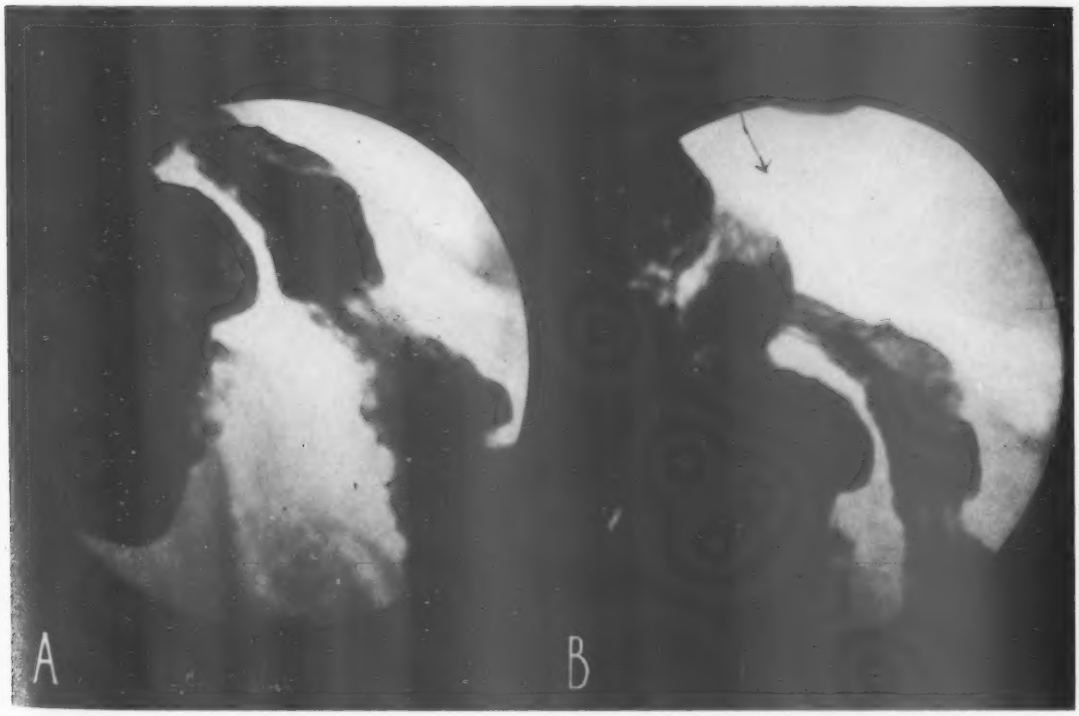

Fig. 2, *A* and *B*. Normal mucosal pattern of the terminal loop of the ileum.

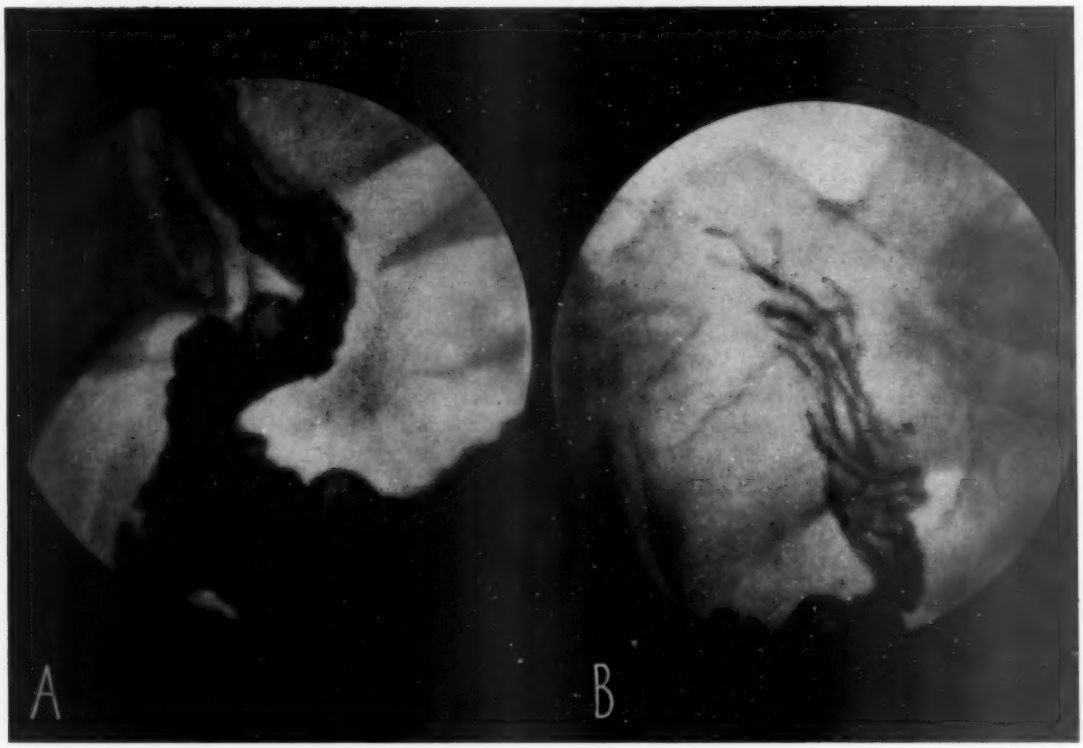

FIG. 3, *A* and *B*. Beginning of the filling of the prececal ileum. Note the peristalsis of the mucosa.

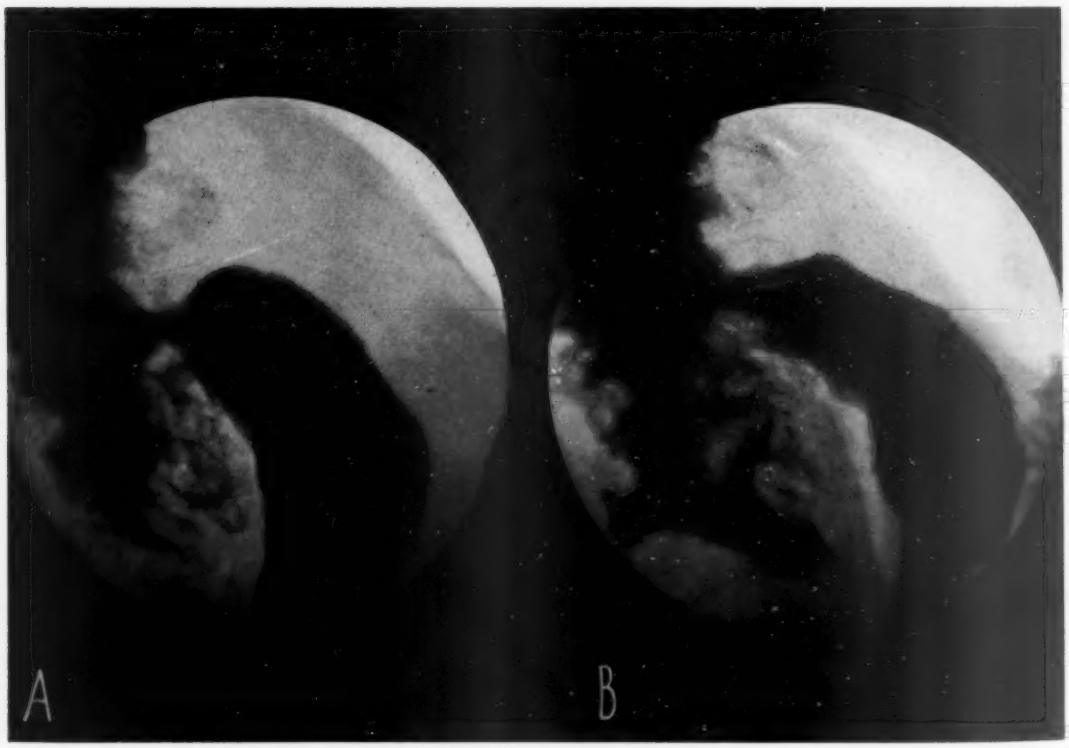

FIG. 4, *A* and *B*. Spindle-shaped peristalsis of the terminal ileum (same case as Fig. 3).

Fig. 5. Autopsy specimen of the terminal ileum and the cecum.

from each other at a fairly constant measurement. Between the two contractions, the ileum is distended and has the shape of a spindle. The pressure inside these spindle-like segments is probably fairly great, for we never were able to compress a spindle to the extent as of being able to visualize its mucosa. The curvatures, during that type of transportation, are strongly and clearly outlined (Fig. 4 *B*). These contraction rings should not be confused with mucosal folds; they are much broader than the folds and appear on *both* curvatures simultaneously. The normal wall of the ileum is so pliable that the slightest peristaltic influence changes the quality and direction of the mucosal folds. We have to emphasize here again what we pointed out in our study of the mucosal pattern of the colon: "that the careful study of the individual folds is just as important as that of the whole mucosal pattern."[8]

We further examined the last loop of the ileum of autopsy specimens. Figure 5 shows very definitely the fine folds in the ileum. These folds are mostly transverse and easily distorted by external influence. They are smaller and thinner than those in the living specimen. This is due to loss of turgor. The size of the folds and the space in between those folds show a certain regularity. The autopsy specimen reveals that in life we are not dealing with artefacts due to pressure or other conditions and that the mucosa of the ileum has a definite pattern which is very regular.

DISCUSSION

Former studies of the last loop of the ileum were made extensively by Becker and Oppenheimer.[2] They compare the ileocecal valve with the pylorus, and the last loop of the ileum with the antrum of the stomach. They even call the prececal loop the "an-

trum of the small intestines." They distinguish between the valve function and function of the last loop of the ileum and describe the rhythmic function of this valve. These authors arrive at conclusions similar to ours. They saw besides the reported mucosal motility at the beginning of the filling, a similar condition during the emptying of the last residue of the contrast substance. They show that this superficial activity, which we called snake-like, is also seen when the ileum tries to get rid of the contrast substance.

Maingot, Sarasin and Duclos[9] discuss the value of examining the terminal ileum. They compare the mucosal pattern to "piled up dishes." Besides the routine method, they discuss the inflation of the last ileal loop by air. This latter method is especially valuable in case of insufficient distention of the gut due to pathological processes (scars, neoplasms or adhesions); however, it does not visualize the undistorted mucosa.

Further studies were made by Forssell who published reproductions of specimens of the ileum. He emphasizes that the form of the relief as to guidance for conclusion is the function of the mucous membrane movements in the small intestine. He describes it as having a high reticulated retention relief with numerous deep digestive chambers, and a straining and barring arrangement with longitudinal folds and fissure-like furrows.

The prececal loop of the ileum is comparatively easily demonstrated roentgenographically because of its position above the mass of the coils of the remaining ileum. The best technique is to use a spot film outfit which permits localization during roentgenoscopy and at the same time permits any kind of compression which is essential. In studying the small intestine, it is still more important to control the amount of compression, for otherwise we might distort the outline of the mucosa, or even by applying too much compression, squeeze the entire contrast substance out of the loop. Under such circumstances, no roentgenological demonstration of the mucosa would result. These examinations, therefore, belong in the hands of the experienced roentgenologist.

SUMMARY

(1) The mucosa of the prececal loop of the ileum has been studied. It shows roentgenologically a definite pattern which is compared with findings in autopsy specimens.

(2) Two types of movements in the last loop of the ileum are described: (a) the surface movement of the mucosa; (b) the ring-like peristalsis, involving all layers of the wall of the ileum.

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THORACIC STOMACH

CASE REPORT

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CASES of complete thoracic stomach are considered of sufficient interest to warrant this case report.

The history of this condition is well covered by Feldman.[1] The following case fulfills the roentgenological criteria mentioned by Feldman as being necessary to support the diagnosis of short esophagus with thoracic stomach. These criteria are: (*a*) the esophagus opens into the stomach above the diaphragm; (*b*) no stream of barium representing the abdominal esophagus is seen to pass below the diaphragm; (*c*) the esophagus is not distorted or curled back on itself; (*d*) the stomach must be shown to stay above the level of the diaphragm and the esophagus must be shown to be too short to reach the level of the diaphragm

CASE REPORT

The chief complaint was dyspnea and pain in the chest. For eighteen years the patient,

Fig. 1. Upright position demonstrating gas bubble in stomach.

aged fifty-eight, has suffered from periodic attacks of dry retching, nausea and vomiting. As a child she thinks perhaps she had more frequent gastrointestinal upsets than the average child, but the real trouble did not start until she began to gain weight eighteen years ago. The attacks come on in different ways, and frequently occur as she begins to eat, while

Fig. 2. Prone position.

eating, or just after eating. The pain in the upper left chest and left shoulder often precedes an attack. When the attack comes on there is considerable dry retching and if she can finally vomit, relief is afforded.

About fifteen years ago, she consulted a gastroenterologist who told her that she had no cancer, about which she was greatly worried. Previous to the attacks of acute nausea and vomiting, she has had attacks of regurgitation of her food, not actual vomiting but not able to keep down much of the food she would eat. In recent months, she has grown short of breath on exertion, and has some chest pain. She has to take laxatives now for constipation, and

[1] Feldman, Maurice. Clinical Roentgenology of the Digestive Tract. Wm. Wood & Co., Baltimore, 1938.

FIG. 3. Left oblique prone position.

milk of magnesia generally gives relief. There has never been any vomiting of blood, nor any blood in the stools. She has never had any jaundice. There is no history of allergy but she notes that alcohol, and acids such as vinegar and pickles will induce an attack. No medicine has ever relieved her.

Past History. Eight years ago the patient had a ruptured appendix and had to have drains inserted. About this time she also had her tonsils removed. The menopause occurred about five years ago and was uneventful. Twenty-five years ago she had typhoid fever, and in 1918 she had an abscess in the throat which was followed by some pus in the kidneys.

FIG. 4. Right oblique prone position.

FIG. 5. After rugar, showing entrance of esophagus into stomach. Right oblique prone position.

Family History. Irrelevant except that a surgeon told her sister that she had a peculiarly shaped stomach when the sister was operated upon. The patient has three children living and well, and has had no miscarriages.

Gastric analysis was as follows:

Free HCl —35	Normal 25 to 50
Total acid—54	Normal 50 to 75
Positive occult blood	

Smears were negative for malarial parasites. Blood Wassermann was negative. Electrocardiogram negative except for left axis deviation. Patient has been much relieved by injec-

tions of reticulogen, which has brought blood count up to normal, and she has no further dyspnea or chest pain.

Roentgen Examination. The patient was first examined with the fluoroscope in the upright position, and it was noted that the first swallow of barium entered the stomach in an atypical manner. In the upright position the cardiac end of the stomach was below the body of the stomach, which was surmounted by a large amount of gas. It was seen that the entire stomach was above the diaphragm. At a subsequent examination, with the patient in the right oblique prone position, one teaspoonful of rugar was given by mouth and its course in the lower end of the esophagus and its relation to the esophageal hiatus were determined. The esophagus was demonstrated to be too short to reach the diaphragm. There was noted a slight narrowing of the esophagus at its junction with the stomach. The remainder of the intestinal tract was negative.

DIAPHRAGMATIC HERNIA AND EVENTRATION

USE OF PNEUMOTHORAX IN DIFFERENTIAL DIAGNOSIS

By WILLIAM B. FAULKNER, JR., M.D.*
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ORDINARILY it is not difficult to distinguish hernia from eventration of the diaphragm. In the latter there is a limited, paradoxical, respiratory diaphragmatic movement; the affected side of the diaphragm is high and well outlined; and the abdominal contents lie below. With hernia, on the other hand, the torn diaphragm is not easily outlined and only a portion of the leaflet may be seen; this is not elevated nor paradoxical in movement; but the herniated stomach, colon, or small bowel can be seen protruding through the diaphragmatic rent into the thorax.

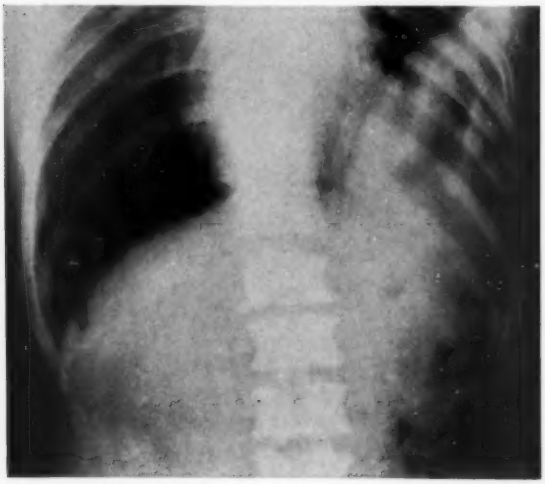

FIG. 1. Roentgenogram of patient who sustained a severe chest injury with multiple rib fractures, fracture of left sternoclavicular joint, and possible phrenic nerve severance.

Cases arise, however, in which these distinguishing features are lacking and the exact diagnosis is rendered uncertain. This is especially true where patients are seen long after having had severe crushing chest injuries, lung damage, bleeding into the pleural cavity, traumatic atelectasis, and high fixation of the diaphragm.

It is in these cases that pneumothorax is of diagnostic value. Air introduced into the pleural cavity will remain within the thorax if the condition is due to eventration; but in the presence of a hernia and patent diaphragmatic opening the air passes into the peritoneal cavity (Figs. 1, 2, 3 and 4).

FIG. 2. After opaque meal there was still a question as to whether the high position of the stomach was due to hernia of the diaphragm or eventration with fixation to the chest wall. No diaphragmatic movement was noted on roentgenoscopic examination.

If one prefers, a pneumoperitoneum may be used to outline the diaphragm; and occasions might arise where the use of pneu-

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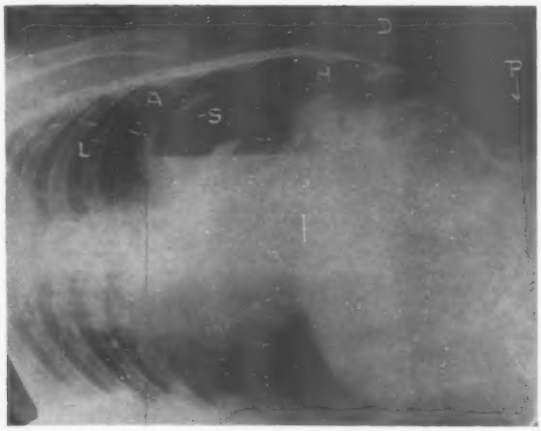

Fig. 3. Roentgenogram in horizontal position following diagnostic pneumothorax. *L*, collapsed lung; *A*, air in the pleural cavity; *D*, lateral segment of diaphragm; *P*, air that has passed from the thorax into the peritoneal cavity; *S*, stomach above the diaphragm (see Fig. 4).

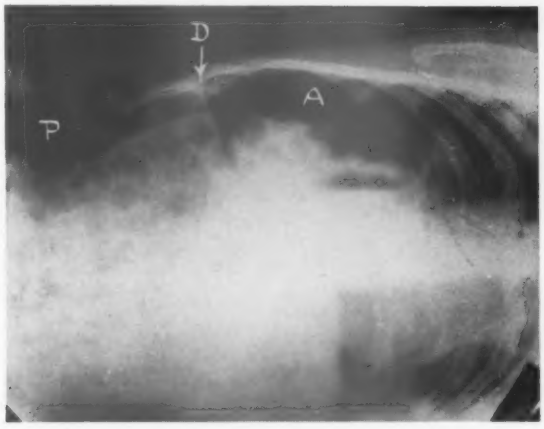

Fig. 4. Diagnostic pneumothorax. *A*, additional air in the pleural cavity; *P*, air that has passed through the torn diaphragm (*D*) into the peritoneal cavity. Roentgen diagnosis (by Dr. John O'Neill): hernia of the diaphragm. This was confirmed at operation.

mothorax first and then pneumoperitoneum would be deemed advisable.

CONCLUSIONS

1. Diagnostic pneumothorax is sometimes helpful in differentiating diaphragmatic hernia from eventration.
2. It is indicated in those cases where the plain roentgenograms and barium studies have failed to settle the diagnosis.
3. Diagnostic pneumoperitoneum is recommended where pleural adhesions prevent the induction of a pneumothorax.

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ROENTGEN IRRADIATION IN THE TREATMENT OF INFLAMMATIONS*

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THE value of irradiation in the treatment of inflammations has been well recognized by radiologists for years.[6,23,36,79,116,170,171,172] The majority of other physicians, however, remain to be convinced of its therapeutic benefits. This healthy skepticism has been due largely to several factors: (1) a lack of well controlled experimental evidence supporting the value of irradiation, (2) the use of other therapeutic procedures in conjunction with irradiation which has prevented adequate analyses of the results attributed to irradiation, and (3) the concern with which doctors view therapeutic measures reported efficacious in a variety of conditions. Recent investigations[37,49,93,115,130,131,152,154] have helped considerably to satisfy valid criticisms concerning the need for reliable experimental data. The second and third factors can be answered only by carefully evaluating one's personal experience and the data published by others.

The present communication is an attempt to analyze the results obtained in 527 patients treated for infections in the Department of Radiology of the Hospital of the University of Pennsylvania. Not all forms of inflammations have been treated by us; therefore, we shall concern ourselves only with those inflammatory conditions with which we have had personal experience (bursitis, carbuncle, cellulitis, draining ears, erysipelas, erysipeloid, furuncle, gas gangrene, granuloma telangiectaticum, herpes simplex, parotitis, pneumonia, sinusitis, and verruca vulgaris).

Opinions concerning the mechanisms by which irradiation influences inflammation vary considerably. This may be accounted for by the lack of reliable information concerning the exact nature of the biological processes enacted after irradiation and the confusion which still exists in the field of immunology.

DISCUSSION OF MECHANISMS INVOLVED IN IRRADIATION OF INFLAMMATIONS

A. Effect upon Bacteria. Wolfenden and Ross,[173] in 1898, were probably among the first to investigate the bactericidal qualities of radiation. Since then, many other reports have appeared in the literature.[7,10,35,115,121,126,174,175] Most of this work was done before dependable methods were employed to determine the quality and quantity of radiation. General conclusions, therefore, are all that can be drawn from such data concerning the bactericidal effects of radiation and these include the following:

1. Radiation in huge quantities (tens of thousands of roentgens) is bactericidal.
2. Soft radiation destroys bacteria more efficiently than hard radiation.
3. The bactericidal qualities of radiation increase with elevation of temperature.

In 1930, Wyckoff[174,175] demonstrated that absorption of one quantum of energy in a vital portion of a bacterium was necessary to produce death. The shape of the survival curve suggested to the author that the vital element in a bacterium occupied about one-twentieth of its cell volume.

In 1933, Korb[93] published one of the first bacteriological studies in which the doses employed were described in terms of roentgens. Korb was unable to demonstrate any effect upon cultures of tubercle bacilli and colon bacilli when he employed hard roentgen rays (220 kv.). When similar quantities of soft rays (50 kv.) were used, however, a

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definite number of bacilli died. Wyckoff, using various monochromatic rays, all of which were softer than those employed by Korb, obtained apparently opposite results in colon bacilli.

The doses employed by Wyckoff and by Korb to injure bacteria would produce irreparable damage if applied in humans. We have been unable to find evidence in the literature to indicate that the small doses of radiation commonly used for infections in man influence bacterial morphology or physiology directly.

While most men agree that the benefits of irradiation are not due to direct germicidal effects of the rays, Webster[165] believes the results could be attributed to bacterial destruction. Normally, bacteria carry a negative electrophoretic charge. It seems possible that radiation might neutralize this negative charge, rendering the bacteria inactive.[35] This concept is theoretical, however, and remains to be proved.

B. Effect upon Normal Cellular Response to Tissue Irritants. The sequences which develop in inflammation have recently been reviewed by Menkin.[108,109,110,111] (This author, who has contributed much to our present knowledge of this subject, will be referred to repeatedly in the following discussion.)

According to Menkin, the earliest change seen in an inflamed area is constriction of the minute blood vessels. This transient process is rapidly followed by vascular dilatation, slowing of the blood current, changes in the endothelial lining of capillaries, and increased seepage of plasma into the extracapillary areas. These transitions are probably the result of the local liberation of a diffusible non-protein nitrogenous crystalline substance other than histamine which has been isolated and recovered from exudates by Menkin (leukotaxine).

This inflammatory phase is rapidly followed by coagulation of the plasma with formation of obstructive thrombi within lymphatics and later within capillaries, which inhibit dissemination of the irritant. As the result of this early "walling-off" process or "fixation" of the irritant, enough time is allowed for phagocytes to collect in the inflamed site. The mechanisms initiating this leukocytic migration remain to be explained. The cytologic picture seems to be determined by the hydrogen ion concentration of the inflamed area, polymorphonuclear cells being attracted by the alkalinity of acute infections, whereas lymphocytes seem to have a greater affinity for the more acid medium of the chronic processes. It is interesting that irradiation is said to produce alkalosis in the treated area.[70]

The rapidity with which "fixation" occurs apparently depends upon the irritant. It has been shown that whereas *Staphylococcus aureus* organisms induce prompt lymphatic blockade in about an hour, cultures of hemolytic streptococci take about two days to effect comparable fixation. The profound systemic reactions observed in streptococcic infections might be attributed to this delayed walling-off process. The possibility that fixation might also explain why certain infections are aborted by irradiation while others suppurate will be discussed later.

Polymorphonuclear leukocytes form the body's first line of defense to pyogenic bacteria. They are actively phagocytic, devouring bacteria and effecting intracellular lysis by means of inherent digestive ferments. Though large numbers of polymorphonuclear cells are killed by bacterial toxins, they serve the body in death by liberating proteolytic enzymes which dissolve dead tissue, thereby hastening recovery. The number of lymphocytes appearing in an acutely inflamed area, with the exception of acute central nervous system infections, is negligible.[8] The function of the lymphocytes is still uncertain. The roentgen sensitivity of lymphocytes[163,164] probably plays a minor part in the response of acute infections to roentgen rays since they occur in greater numbers in chronic infections. Whether the more resistant polymorphonuclear cells are destroyed by doses of 75 to 200 r commonly used for localized infections is problematical. Polymorphonu-

clear cells possessing no phagocytic power after death, it is not surprising that Fried,[48] Pomeroy,[133] and others,[152] found no difference in the bactericidal power of destroyed leukocytes (pus) removed from the same lesion before and after irradiation.

The radiosensitivity of leukocytes, especially lymphocytes, was first demonstrated in animals by Heineke[67] in 1903 and subsequently confirmed by Warthin,[164] Warren and Whipple,[162] Taylor, Witherbee, and Murphy,[155,156] and others,[15,61,118,119] all of whom used large portals and excessive quantities of radiation to produce their effects. Results reported by Westman[167] seem more applicable to the present problem. With doses comparable to those employed in treating infections, Westman observed initial increases in white blood counts which rapidly fell below normal with further irradiation. Whether similar leukocytic responses occur in humans irradiated for infections is still uncertain as confirmatory data are lacking.

Desjardins,[30,31,32] Pordes,[134] and others,[105,124] have attributed the beneficial effects of irradiation in infections to the radiosensitivity of leukocytes. These investigators believe that the early destruction of leukocytes by irradiation sets free protective antibodies more quickly than one usually observes in the natural course of inflammatory processes. It is our impression that the vascular responses to irradiation (to be discussed later) are of more importance in controlling the acute infections than leukocytolysis. In the chronic inflammatory processes, however, in which larger total doses of radiation are usually employed, the destruction of leukocytes and young fibroblasts may be of significance.

The reactions of the so-called reticulo-endothelial cells to small doses of radiation are also unsettled. Castellino[14] and Tannenberg and Bayer[154] have reported evidences of reticulo-endothelial stimulation with small doses which have not been verified by Chrom.[18,19] It is only fair to state that Chrom irradiated the entire animal with doses of 500 to 1,000 r. One thing seems certain, quantities of radiation large enough to depress the peripheral blood count may also depress the reticulo-endothelial system,[104] rendering the host more susceptible to bacterial invasion.[18,21,22,80] This untoward reaction has been utilized experimentally by bacteriologists to depress the resistance of animals to infection, thereby permitting florid bacterial growth in vivo.[176,177]

C. Effect upon Normal Immunological Responses. In 1907, Crane[24] reported increases in the opsonic index of patients irradiated for infections which have since been confirmed by Heidenhain and Fried,[66] Fried,[50] Hartley,[65] Hektoen,[68,69] and Westman.[167] These investigators are in accord that the bactericidal quality of blood is enhanced by small doses of radiation. The effects are transient and reach a peak forty-eight to seventy-two hours after exposure.

While the evidence indicates that the benefits of small doses of radiation in infections are negligible, once antibody formation is at its height,[48,69] we could find nothing to indicate that these doses might do harm by directly affecting the antibodies already present. It must be remembered that these conclusions apply only to small quantities of radiation. Larger doses or repeated small exposures unquestionably depress the inherent protective mechanisms of the body to infection.[18,176] Murphy and Morton[118] concluded that the lymphoid structures are the source of antibody formation since radiation in quantities sufficient to damage lymphoid structures also retard antibody production.

In the light of recent evidence, bacteriolysins, precipitins, and agglutinins are no longer considered specific forms of antibodies but as terms descriptive of the reaction observed when antigen and antibody are mixed.[157] Most authorities agree that antibodies are specialized globulins which appear in blood serum or body fluids in response to an irritant with which it reacts specifically. There is evidence that irradiation increases the globulin in colloidal se-

rum protein.[37] Until more is known concerning the exact character and mode of origin of true bactericidal globulins, one might postulate that the altered albumin globulin ratio produced by irradiation enhances antibody formation. Whether this is a factor in the favorable reactions observed following roentgen therapy still remains to be proved.

D. Effect upon the Vascular System. Dilatation of the capillary network and subcapillary plexus stands out as a uniformly characteristic response to small doses of radiation (200 to 300 r). Recent investigations[71] in humans indicate that these vascular changes manifest themselves within six hours of the time of irradiation, occurring more promptly with low voltage rays (50 kv.) than with harder radiation (200 kv.). Though still evident twenty-four hours after irradiation, the degree of vascularization is less intense. At no time have thrombi been observed of the type described by Menkin in "fixations." The entire picture has indicated an increase in the rate and quantity of blood flow through the irradiated area of the type seen in *active hyperemia.*[27]

Under optimum conditions, inflammation ought to produce so much vascularization and engorgement that irradiation could do little more. This does not militate against the fact that irradiation may do good. Experience has taught radiologists the desirability of irradiating infections through portals large enough to extend beyond the border of infection. This induces an increase in blood flow not only in the periphery of the lesion but, what may be more important, in the larger area of normal tissue underlying the infection. It would seem, therefore, that what was originally an area of *passive hyperemia* had been transformed into an area of *active hyperemia* as the result of the irradiation. That such events follow seems substantiated by the throbbing and exacerbation of pain in treated areas and sudden chills and fever which have been commonly observed four to six hours after irradiation. We believe this active hyperemia to be of considerable importance in radiation therapy of infections. It not only increases the temperature and local concentrations of electrolytes by increasing blood supply, but also decreases edema by increasing lymphatic flow, all of which increase the efficiency of antibodies.

It is a common observation that infections may be aborted when treated early, and when treated late, may suppurate. Such differences have been attributed to variations in cellular infiltration. We believe Menkin's observations, reviewed above, may explain the facts more satisfactorily.

Menkin[108] observed that the rate and degree of fixation vary with the irritant. Thus, using *Staphylococcus aureus* as an irritant, he[110] noted prompt lymphatic and capillary blockade, whereas fixation to hemolytic streptococcus was considerably delayed (two days). In view of these data, we believe it reasonable to postulate that the degree of fixation of an infection at the time the lesion is irradiated largely determines whether or not incision and drainage will be necessary. If lymphatics and capillaries are not completely thrombosed and can be encouraged by "active hyperemia" to carry away inflammatory debris, resolution will be satisfactory. If, however, fixation is complete, the chances for complete involution without surgical drainage become considerably less.

How irradiation reduces the pain of infections is a moot problem. Some believe it the result of protein and lipoid changes in the region of nerve endings,[104] or leukocytic destruction.[30] We believe the relief of pain is more closely associated with the rapid elimination of toxins and edema attending the artificially induced hyperemic state.

PHYSICAL FACTORS OF TECHNIQUES EMPLOYED

In order to avoid repetition, the various physical factors employed will be referred to in the text as:

Technique No. I
120 kv., 5 ma., 30–40 cm. skin-target distance; no filter.

Technique No. II
120 kv., 5 ma., 30–40 cm. skin-target distance, 1 mm. Al.

Technique No. III
120 kv., 5 ma., 30–40 cm. skin-target distance, 5 mm. Al.

Technique No. IV
120 kv., 5 ma., 30–40 cm. skin-target distance, 0.25 mm. copper +1 mm. Al.

Technique No. V
50 kv., 4 ma., 3–5 cm. skin-target distance, equivalent of 0.2 mm. copper.

Technique No. VI
200 kv., 15 ma., 50 cm. skin-target distance, 0.5 mm. copper+1 mm. Al.

Doses are referred to in terms of roentgens in air applied to the skin without backscatter.

BURSITIS

This affection has been described involving almost every bursa in the body closely related to a joint. Listed among these are the shoulder, hip, knee, elbow, wrist, metacarpal, phalangeal, and ankle joints. The shoulder is by far the most frequent site for this type of involvement.

TABLE I
BURSITIS

Date	Author	Number of Cases	Result: Percentage Benefited
1936	Lattman[96]	20	75
1937	de Lorimier[29]	31	100
	Present series	90	64

The clinical symptoms are distinctive. Agonizing pain is characteristic. Usually disabling, the pain is aggravated by the slightest motion and is worse at night. In "subdeltoid bursitis" the discomfort is most acute over the greater tuberosity, occasionally radiating over the entire shoulder, up the back of the neck, and down the arm.

Tenderness over the entire shoulder, particularly just below the acromial process and over the greater tuberosity, is almost invariably present. The coracoid process and bicipital groove may also be sensitive to palpation. Attempts to abduct or rotate the arm beyond 10 degrees meet with marked resistance and exacerbations of pain. Inability to put the hand on the head or behind the back are observed frequently. In some instances, flexion and extension are also extremely uncomfortable. In our experience, roentgen examination of these shoulders reveals calcifications in the region of the greater tuberosity in about 50 per cent of the patients examined. Not infrequently calcification in the region of the supraspinatus tendon is found on the unaffected side and is not present in the affected shoulder. Usually in patients with acute symptoms, the appearance of the calcification on the affected side is homogeneous and putty-like, whereas the calcification seen in chronic cases is more granular. In some instances there is considerable swelling and distention of the bursa due to fluid.

Codman[20] believes bursitis to be the result of minor strains or injuries which produce minute ruptures in the supraspinatus tendon with the formation of blood clots in which calcium is deposited. According to Carnett[12] the lesion starts as a tendonitis which undergoes local necrosis and calcification. Meyer[113] contends that the changes are the result of constant movement of soft parts on each other with roughening, fraying, and in some instances, complete obliter-

TABLE II
BURSITIS
Total number—90 cases

	Rapid Improvement in Less than 3 Days	Improvement in 3 to 5 Days	Little or No Effect on Normal Course
Number of patients	47	10	33
Results	52%	12%	36%

ation of the smooth inner surface of the subacromial bursa. In spite of these differences, it is agreed that most calcified deposits occur in the substance of the supraspinatus tendon. They may also occur in the tendons of the subscapularis, teres minor, and infraspinatus.

Of paramount importance in the treatment of acute subdeltoid bursitis is complete immobilization. Placing the arm in a sling does not immobilize the part sufficiently. The most ideal immobilization is to have the patient go to bed and give sufficient sedative medication to insure absolute quiet. Unless this is accomplished, no form of local therapy or analgesic will give the desired relief in a short period of time. Incision and drainage of the bursa and tendon are frequently followed by complete relief.[44] Another highly favored method of treatment is the injection of novocaine into the bursa and tendon.[60] Saline irrigations for the removal of the calcium deposits have also been used successfully.[128]

Multiple needle punctures have been used for years with improvement.[166] Others have recommended local heat, especially diathermy. Recently, interest in roentgen therapy for acute bursitis has been stimulated by numerous favorable reports[3,16,29,40,58,82,96,145] (Table I).

Approximately 60 per cent of patients treated with roentgen rays improve rapidly (Table II). Ordinarily the acute symptoms subside in one or two weeks without treatment. The usual course in patients benefited by irradiation is less than one week (three to five days). There are some patients who have an acute swelling of the subacromial bursa as a complication of the ordinary acute bursisis. In these cases it is *essential* to drain the bursa surgically before giving any irradiation, otherwise irradiation will make the patient more uncomfortable.

The presence or absence of calcification seems to be of no significance in determining the response to irradiation. Indeed, the

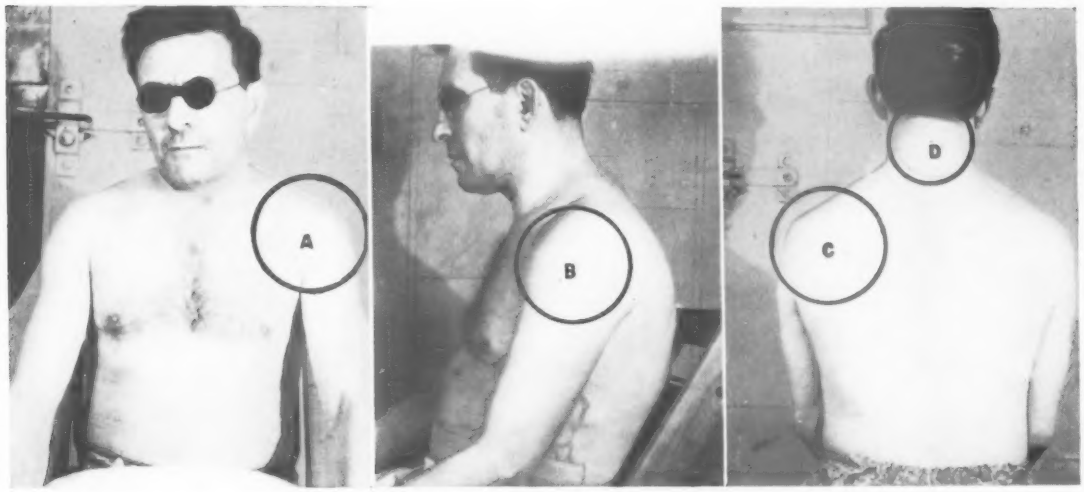

Fig. 1. *Bursitis.* Treatment directed through any one or all of the portals outlined above depending upon point of maximum tenderness. By selecting multiple portals, *A*, *B* or *C*, the skin tolerance to irradiation is maintained. Portal *D*, which includes the cervical and upper thoracic nerve roots, is employed in patients with atypical shoulder pain who have not responded to shoulder irradiation. It is extremely difficult to evaluate results of irradiation in patients with bursitis unless recovery is prompt. It must be remembered that patients who do not improve until a week or longer has elapsed after roentgen therapy might have improved in the same period of time if nothing were done. Outline of average treatment: 120 kv., 5 ma., 40 cm. skin-target distance, 0.25 mm. Cu plus 1 mm. Al filtration.

1st day—150 r 2nd day—150 r 3rd day—100 r

common occurrence of unilateral pain in patients with bilateral supraspinatus calcifications and the presence of typical pain in the absence of calcification make one question the significance of granular calcium deposits in subdeltoid bursitis.

In our experience, 100 to 150 r, using Technique III, IV, or VI (depending upon thickness of shoulder) repeated at twenty-four hour intervals for two or three treatments have been enough to control pain. Occasionally, six or eight exposures have been necessary. Under such circumstances, multiple portals have been utilized to preserve the skin tolerance to irradiation (Fig. 1). Occasionally, patients complain of an increase in severity of pain four to six hours after the initial treatment. This may be considered a favorable sign as it is usually followed by rapid recovery. We are not certain whether or not irradiation is attended by more rapid calcium resorption than is evident following any other form of non-surgical therapy.

In evaluating the results of roentgen therapy in the treatment of bursitis, care must be taken to exclude chronic or obliterative bursitis, cervical neuritis, cervical arthritis, infectious arthritis of the shoulder joint, and heart disease. These conditions, usually associated with shoulder pain, are less responsive to roentgen therapy than bursitis. Patients with chronic bursitis complain of pain in the shoulder but do not have marked limitation of motion unless the shoulder joint has been kept inactive for long periods. In such instances the scapula moves with the humerus, and the limit of movement depends upon the mobility of the two structures.

Obliterative or chronic adhesive bursitis is characterized by the inability of the patient to move the arm through its normal motions at the shoulder, muscle atrophy, and shoulder pain.

The roentgen therapy of chronic bursitis is somewhat more protracted than with the acute. In all instances attempts are made to clear up focal infections, place the part at rest for a week or ten days, and give roentgen therapy using Technique III, IV, or VI. One or two treatments a week may be given and the treatments may extend over a period of a month to six weeks. Not infrequently combined ultraviolet, infrared or short wave therapy may assist the roentgen therapy in obtaining a satisfactory result in a condition that is otherwise most resistant. We think that a great many cases of chronic bursitis are due to unusual trauma in individuals approaching the period of "measured activity," the forty, or even fifty and sixty year age periods. Rowing, golf, gardening, fishing are a few of the predisposing sports. Bursitis is usually found in the well nourished individual. One wonders at times if it might be a manifestation of gout. Only occasionally do we see the condition in the hard working, every day laborer.

Cervical neuritis (c-5) (c-6) may be identified by sensory changes in the region of the shoulder and temporary weakness of the deltoid. This condition, usually due to a focus of infection, is not associated with limitation of motion. In cervical arthritis, the pain is more of an ache which radiates not only into the shoulder but over the front of the chest and side of the head along the course of the superficial branches of the cervical plexus. Deep palpation over the cervical spine frequently produces pain. Roentgen examination of the cervical spine usually reveals the true nature of the disease. Not infrequently the pain in these patients may be relieved by irradiation of the cervical spine. Infectious arthritis and cardiac disease present symptoms other than shoulder pain which should help in identifying them.

The principles described above concerning the use of irradiation in acute or chronic subdeltoid bursitis apply equally in the treatment of bursitis in other parts of the body. Our experience has been limited to acute bursitis in the region of the hip, elbow, wrist, and ankle. In these areas the results have been uniformly good.

CARBUNCLE

A carbuncle is a suppurative inflammation of the skin and subcutaneous tissues due to the invasion of staphylococci. It consists of a series of communicating abscesses which, due to the nature of the tissue in which they originate, discharge through separate openings on the surface. As the infection progresses, suppuration and liquefaction may extend over a considerable area.

The treatment of carbuncles depends upon the general condition of the patient and the stage in which it is first seen.

Carbuncles being relatively more common in debilitated individuals, care must be taken to identify chronic diseases such as diabetes, cardiac diseases and nephritis.[17] Septic patients must be given fluids, electrolytes, transfusions, and other supportive measures to bolster the natural defensive mechanisms of the body. Care must also be taken to splint the affected area to prevent spread of the disease. Lesions occurring in the neck need little fixation as the pain and muscle spasm prevent motion. Around the mouth and nose, however, it is of paramount importance to warn patients against talking or moving the affected portion of the face in any fashion. The oral administration of food and liquids must also be stopped and parenteral methods resorted to for maintaining adequate intake.

TABLE III
CARBUNCLES

Date	Author	Number of Cases	Result: Percentage Benefited
1916	Dunham[36]	67	100
1923	Lewis[99]	16	87
1924	Hodges[73]	9	88
1927	Carp[13]	28	50
1930	Light and Sosman[100]	50	68
1935	Firor[45]	56	One death, small incision in most cases
1937	King[88]	33	66
	Present series	20	65

When seen early, true carbuncles respond readily to irradiation and may be aborted if the general health of the individual is satisfactory (Table III). The usual course of events consists in an exacerbation of pain four to six hours after irradiation with considerable relief within twenty-four hours. As a rule, either Technique II, III or IV is employed, delivering approximately 150 to 200 r to a portal beyond the confines of the lesion (Fig. 2). Treatments are usually given daily or every other day, depending upon the rapidity of involution. Whether or not hot or cold medicinal compresses should be continued during irradiation is problematical. We believe *irradiation serves the purpose of a highly efficient poultice* and therefore we can see no reason for using compresses early. After the lesion begins to suppurate, however, we believe moist dressings are useful to prevent scab and crust

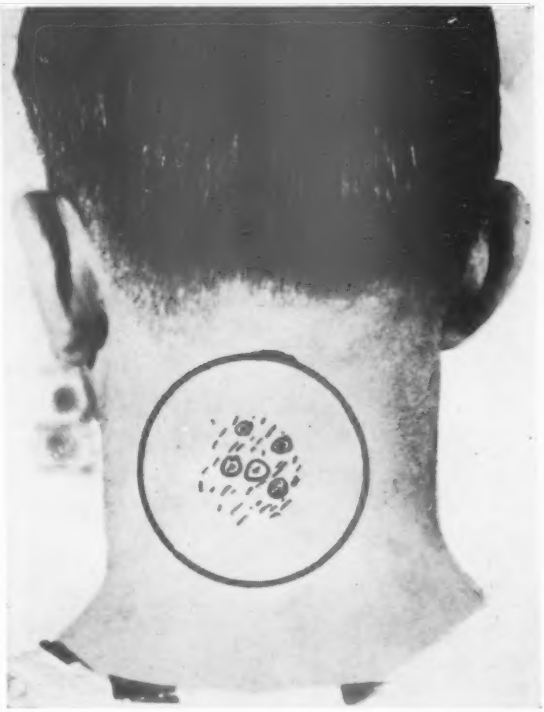

FIG. 2. *Carbuncles.* Portal extends about 3 cm. beyond area of induration. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 5 mm. Al filtration.

1st day—175 r 4th day—no treatment
2nd day—125 r 5th day—100 r
3rd day—125 r 6th day—no treatment

formation, thereby facilitating drainage. Irritating medicaments such as ichthyol and iodine are avoided for obvious reasons.

When softening occurs, an almost invariable occurrence in lesions treated late, a small incision is usually sufficient to establish drainage. The wound must be kept clean and dead tissue removed. All hair around the lesion should be shaved and the surrounding skin cleaned with soap and mild antiseptics to prevent auto-inoculation and reinfection. The treatment of these lesions requires close cooperation between the surgeon and radiologist. In this manner, most patients may be assured a shorter period of morbidity and a less deforming scar.

TABLE IV

CARBUNCLES

Total number—20 cases

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect	Died
Number of patients	9*	4†	5‡	2§
Results	45%	20%	25%	10%

* One patient in this group incised.
† One patient in this group incised.
‡ Three patients in this group incised.
§ Both patients in this group incised.

Many reports may be found in the literature (Table III) attesting to the beneficial effects of irradiation in the treatment of carbuncles.[36,45,50,51,56,73,74,75,88,99,100,143] The results reported since the dissension of Frick[46] and Carp[13] have been uniformly good. The latter, comparing results following roentgen therapy (28 patients) with a similar group (125 patients) treated with surgery, poultices, and other methods, concluded that irradiation was of no value in the treatment of carbuncles. Approximately 90 per cent of the patients were benefited by procedures other than irradiation, whereas 50 per cent improved following irradiation. The mortality was approximately the same in both groups. While our results have not been as uniformly successful as others, we have reason to feel encouraged to continue its use (Table IV). It is noteworthy that none of the patients with carbuncles who were irradiated developed blood stream infections. Two of the 20 patients treated with roentgen rays died. In both instances the carbuncle was on the upper lip and had previously been incised.

CELLULITIS AND LYMPHANGITIS

Cellulitis is a diffuse suppurative inflammation in which tissue necrosis may be extensive but with relatively little pus formation. The causative pathogenic organisms are usually streptococci which induce an intense and widespread vascularity and outpouring of serum rather than local abscess formation. Lymphangitis is an inflammation of the lymphatic vessels due, as a rule, to streptococci. Both diseases being somewhat similar, they have been included in one group in order to increase the total number of cases to be analyzed.

The successful treatment of cellulitis and lymphangitis comprises (1) prompt recognition and attention to the portal of entry of the original infection; (2) rest for the infected part; (3) general supportive procedures, and (4) active measures to enhance local immunologic processes.

In seeking a portal of entry, care must be taken not to overlook puncture wounds, cuts, bruises, and blisters, no matter how harmless they may appear. Once recognized, the most careful judgment is necessary to determine whether rest or incision may be indicated, a responsibility radiologists should share with competent surgeons. Regardless of the procedure decided upon, complete bed rest and elevation of the affected part are of paramount importance. General supportive measures include adequate fluid and caloric intake with blood transfusions when necessary. Chills, high fever and prostration should be treated. Blood cultures should be taken.

The institution of complete bed rest, hot wet dressings and supportive care often rapidly terminate the course of these infections. Reports by others[26,50,56,134] suggest

that roentgen therapy may be of added value.

Irradiation is not meant to take the place of the therapeutic procedures outlined above but is used as a complementary measure. While we have seen no special benefits attributable to the use of wet dressings plus irradiation compared with irradiation alone, we hesitate to advise against moist applications until we have had more experience in treating cellulitis and lymphangitis. When combined treatment is employed all dressings must be removed and then reapplied lest radiation be filtered out by the heavy metals (lead and magnesium) usually used for wet dressings. Antiseptic solutions are reported to have no value.[17] Since some antiseptics render the skin more susceptible to irradiation, in general we advise against them.

In treating lymphangitis and cellulitis, care must be taken to irradiate the original focus of infection, the area of spread, and the tender nodes which may lie at a distance from the infection. Thus, in lymphangitis spreading up a lower limb due to a blistered toe in a patient who has tender femoral lymph nodes, irradiation, to be adequate, must extend from the foot up to and including the nodes, care being taken to protect organs of reproduction from the rays. This may be accomplished with multiple small portals (Fig. 3), or by treating at a longer distance to cover a larger area. As a rule, we do not exceed a total of 300 r per treatment, using Technique II, III or IV, depending upon the degree of induration.

TABLE V

CELLULITIS

Total number—48 cases

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect
Number of patients	37	4	7*
Results	78%	8%	14%

* One patient in this group died.

FIG. 3. *Lymphangitis.* Focus of infection over ankle with lymphatic streaking up the leg involving femoral and inguinal lymph nodes. Three large portals, *A*, *B* and *C*, cover the entire lower limb from site of origin to nodes in groin. Outline of average treatment: 120 kv., 5 ma., 40 cm. skin-target distance, 5 mm. Al filtration.

1st day—100 r—Portal *A*
1st day—100 r—Portal *B*
1st day—100 r—Portal *C*
2nd day—100 r—Portal *A*
2nd day—100 r—Portal *B*
2nd day—100 r—Portal *C*
3rd day—100 r—Portal *A*

Sharp, shaking chills and abrupt rises in temperature occasionally develop about six hours after irradiation. The most prompt regressions are seen in the areas last invaded. This allows one to decrease the size of the area treated from day to day until the infection has been completely controlled. Usually two or four exposures suffice when the treatment is instituted early (Table v). When treatment is started later, as in unusually virulent infections, irradiation seems to help localize the area of suppuration, making mutilating incisions unnecessary.

We have had little experience in treating these diffuse infections with sulfanilamide plus irradiation. The combined treatment has been avoided to permit evaluation of each therapeutic method. While the data are limited, the results have been comparable in both groups in the absence of septicemia. The value of sulfanilamide in streptococcic septicemia being established, it

seems reasonable to use the drug in preference to irradiation in the treatment of streptococcic cellulitis or lymphangitis, for what a drug can cure it may even prevent.

TEMPORAL BONE DISEASE

In 1932, Schillinger[147] and Ross[144] observed that irradiation produced a marked improvement in patients with acute middle ear and acute mastoid disease within twenty-four hours after exposure. More recently Lucinian[102] and Dowdy, Heatly and Pierce,[34] comparing results obtained in a group of patients irradiated for acute otitis media with a control group, called attention to a greater incidence of complications and morbidity in patients not irradiated. Similar results have been published by others[59] irradiating one ear in patients with bilateral disease, the untreated side serving as control.

TABLE VI

CHRONIC DRAINING EARS

Total number—18 cases

	Drainage Stopped	Drainage Less Profuse	Little or No Lasting Effect
Number of patients	6	1	11
Results	34%	6%	60%

Our experience in treating these acute temporal bone infections with irradiation has been limited. We have seen enough, however, to encourage us to continue using it providing there exists no evidence of cellular destruction.

As a rule, we deliver 100 r, using Technique III or IV, to the infected area, care being taken to include all of the area of the temporal bone. Exposures are repeated at twenty-four to thirty-six hour intervals, depending upon the status of the disease. Swelling and redness of the tympanic membrane and canal wall decrease after the first exposure. Usually soreness and tenderness also diminish within forty-eight hours, by which time hearing has also increased. In most instances, three or four treatments are enough to control the infection. Close cooperation between the otologist and radiologist is of extreme importance. Unless free drainage through the tympanic membrane and auditory canal is secured and maintained, irradiation will not be attended by optimum results, and the dangers of a mastoid abscess and perhaps septicemia become imminent.

The treatment of chronic discharging ears is disappointing in many instances (Table VI). Usually the result of repeated or persistent infections, chronic discharging ears are associated with either chronic otitis media, chronic mastoiditis, or both. Its curability is somewhat in proportion to its chronicity and the pathologic changes in the temporal bone. Draining ears of recent occurrence and slight morbid changes seem to respond more favorably to irradiation than aural discharges of longer duration.[25] However, in some instances, chronic discharging ears will get well following irradiation even though they have been draining for years. As in the acute processes, the otologist and radiologist must confer frequently if the best interests of the patient are to be served.

Patients with chronic discharging ears do not, as a rule, complain of mastoid pain and tenderness. Tinnitus aureum and impaired hearing occur frequently. Before instituting treatments roentgenograms of both temporal bones are obtained to determine the morphology of the disease being treated.

In such instances particular care is taken to question all individuals as to whether they have been treated previously with sulfanilamide and its related drugs. Unless this precaution is observed one is likely to make more errors in interpreting mastoid roentgenograms. In patients receiving chemotherapy the degree of mastoid involvement manifest roentgenographically is frequently out of proportion to the clinical findings. In such instances, we believe roentgen therapy is contraindicated as it would tend to delay operation, and operation may be the only procedure that will prevent the development of meningitis.

More frequently the patient reveals clinical evidence of mastoid disease which may be overlooked in the roentgenograms because the changes are so slight.

We have found that sclerotic infantile mastoids and mastoids containing cholesteatomas are rarely permanently relieved by roentgen therapy. Patients with these changes are treated routinely, however, as unexpected and dramatic improvement may ensue. Treatment is terminated in about one month if no definite improvement is observed. More favorable results have been observed in infections associated with chronic granulation tissue formation in the middle ear and its recesses.

The treatment of chronic aural discharges may extend over a period of months. Doses of 100 to 175 r, using Technique III and IV, are delivered to the involved area once or twice a week until 600 to 800 r has been delivered to the skin surface (Fig. 4). Patients should be properly warned of the possibility of epilation. This has never been permanent in our experience. Throughout the course of irradiation, care must be taken to maintain adequate drainage. Crusts and clots should be removed by daily irrigations of warm boric acid solution following which the canal should be dried. Dry wicks and suction may also be used in more freely draining ears.

Chronic aural discharge is frequently associated with catarrhal infections of the nasal pharynx and sinuses. In others, allergy, endocrine disturbances, or general debility aggravate the condition. Unless these factors are investigated and controlled, irradiation will prove of little therapeutic value. In our experience, irradiation of the nasal pharynx has been regarded as an essential part of the treatment.

Changes in the character and quantity of drainage are the earliest manifestations of effective irradiation. In many patients there occurs a diminution of itching and burning in the ear which are manifestations of secondary skin infections in the auditory canal and pinna. In most instances, the auditory acuity increases as the discharge decreases. This is in accord with O'Brien's[122] and with Crowe and Baylor's[25] encouraging findings in patients treated for catarrhal deafness with roentgen therapy.

Fig. 4. *Chronic draining ear.* Portal includes entire mastoid region, the beam being directed along the axis of the petrous pyramid. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 0.25 mm. Cu plus 1 mm. Al filtration.

1st day—125 r 5th day—125 r
2nd day—125 r 8th day—100 r
11th day—100 r

Otologists commonly use silver nitrate, mercurochrome, iodine powder, iodoform, and other irritants in treating chronic draining ears. We prefer that such procedures be discontinued during the period of and for several weeks after irradiation.

The importance of warning patients with chronic aural infections against swimming cannot be overemphasized.

ERYSIPELAS

Erysipelas is an acute spreading infection due to a hemolytic streptococcus, affecting chiefly the lymph spaces of the skin.[8] The disease spreads rapidly with a

TABLE VII

ERYSIPELAS

Authors		Ude and Platou[159]	Widmann[168]	Symmers and Lewis[153]	Nelson, Rinzler and Kelsey[120]	Knapp[90]	Present Series
Number of cases		343	194	19.975	695	510	
Control series	*Days	9	10				
	Mortality	19%	10%	10%			
Roentgen irradiation	*Days	5	5				5
	Mortality	12%	6%				8%
Ultraviolet radiation	*Days	5				4	
	Mortality	6%				7%	
Antitoxin	*Days						
	Mortality			7%	9%		
Sulfanilamide	*Days						
	Mortality				2%		

* Average duration of illness in days.

slightly raised bright or dull red border. The inflammatory cells are mainly lymphocytes[8] which seems remarkable as the characteristic defense cell in most infections is the polymorphonuclear leukocyte. Two types of erysipelas are recognized: (1) the facial type, usually limited to the face, head and neck, and (2) the body and extremity type which is usually a more severe infection. The disease sets in abruptly with a chill, fever, and leukocytosis.

TABLE VIII

ERYSIPELAS

Total number—36 cases

	Rapid Improvement in One or Two Days	Normal Course Shortened Moderately	Little or No Effect on Normal Course	Died
Number of patients	30		1	5*
Results	83%		3%	14%

* Two of the 5 patients who died were moribund when the first roentgen treatment was given.

The first step in the treatment of erysipelas is the isolation of the patient and institution of infectious precautions. Toxemia is common and must be combatted by adequate salt, fluid, and caloric intake. Since erysipelas occurs commonly in diabetics, alcoholics, cardiacs and nephritics, care must be taken to recognize and treat these systemic diseases while attacking the acute infection.

The multiplicity of therapeutic measures advocated in the past, such as vaccines,[77,120,153] collodion, cold compresses, antitoxin, ultraviolet radiation,[90,159] iodine, and carbolic acid,[17,76] indicates how inadequate treatment for erysipelas has been (Table VII). During the last fifteen years increased attention has been directed to the use of roentgen irradiation,[1,31,53,54,56,57,64,74,75,95,101,159,168] and more recently, sulfanilamide, in this disease. In analyzing rather sizable groups of patients treated with sulfanilamide, it would seem that this is the most effective form of therapy thus far used in the treatment of ery-

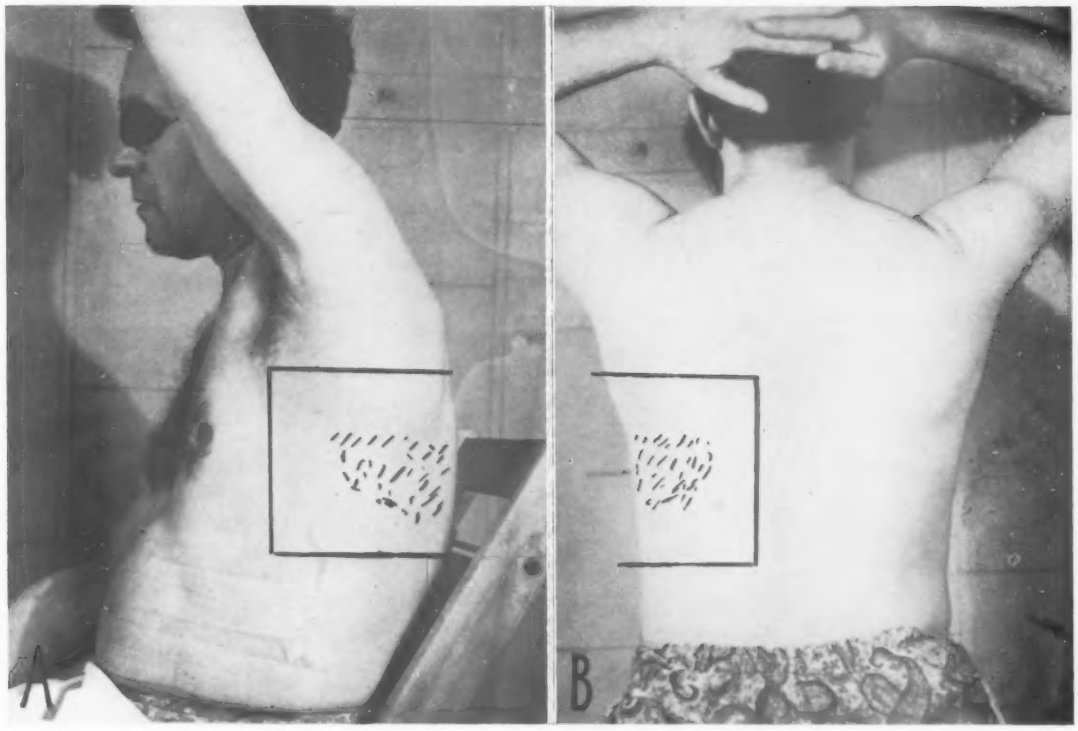

Fig. 5. *Erysipelas.* Lesion on lateral chest wall extending posteriorly. Multiple portals used in order to assure adequate surface dose. Diseased area is shaded. Outline of average treatment: 120 kv., 5 ma., 40 cm. skin-target distance, 1 mm. Al filtration.

1st day—100 r—Portal *A*
1st day—100 r—Portal *B*
2nd day—100 r—Portal *A*
2nd day—100 r—Portal *B*

sipelas. Nelson, Rinzler and Kelsey,[120] and Hoyne, Wolf and Prim[77a] using sulfanilamide have reported the best results. Hoyne and his co-authors reported a mortality of 2.5 per cent in the treatment of erysipelas with prontylin.

Whether patients being treated with irradiation for erysipelas should also be given sulfanilamide is a moot problem. Kelly[87] believes that large doses of sulfanilamide inhibit the beneficial effects of irradiation and suggests that the anoxemia or other blood changes associated with sulfanilamide therapy may account for the less satisfactory results. In our experience the combination of roentgen rays and sulfanilamide has not been harmful.

The limited number of patients included in Table VIII does not allow us to draw conclusions. Certain observations seem interesting.

Almost one-half of our irradiated patients had marked febrile reactions four to six hours after exposure. In most instances, the fever dropped rapidly with definite relief of itching and burning within twenty-four hours. Others have reported similar observations following roentgen therapy.

Approximately 20 per cent of the patients remained well after the first day. Our best results were obtained in the facial group. The response was more rapid and the morbidity and mortality lower than in the body type of erysipelas.

In treating erysipelas, care must be taken to go wide of the margin of the lesion. Unless this is done, the lesion continues to spread along the untreated border. This applies particularly to convex surfaces like the head and extremities where the target skin distances increase toward the periphery of the field. In such instances the de-

creased intensity of radiation in the periphery of the convex field may be compensated for by using multiple converging beams (Fig. 5).

As a rule 100 r per portal, using Technique I, II, or III, is delivered over the area being treated. If the lesion is widespread, multiple small portals or several larger portals are employed, the total dose never exceeding 300 r per day. Two or three such exposures are usually sufficient to control these infections. Patients should be warned of the possibility of epilation and signed permission obtained before starting roentgen therapy. In our experience doses of 300–400 r delivered in three to four days have never produced permanent epilation.

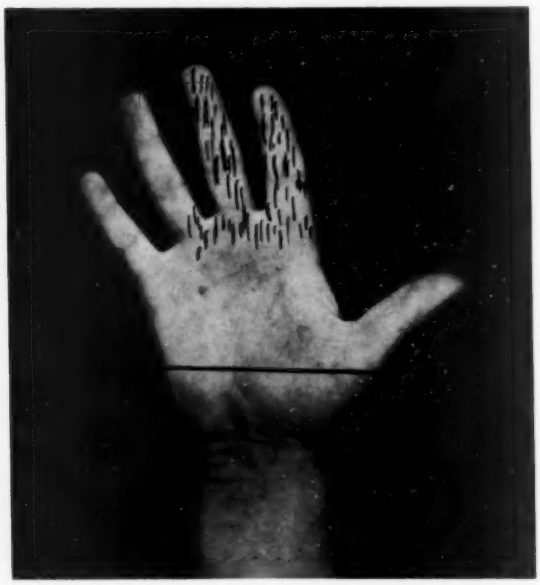

FIG. 6. *Erysipeloid.* Treated portal is considerably larger than the involved area. Diseased area is shaded. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 1 mm. Al filtration.

1st day—150 r
2nd day—150 r
3rd day—100 r
4th day—no treatment
5th day—no treatment
6th day—100 r if necessary

ERYSIPELOID

Rosenbach's erysipeloid is a rather mild localized cutaneous infection produced by *Erysipelothrix rhusiopathiae*. As a rule, pain at the site of infection is the first symptom. Swelling and erythema soon follow. The most distinctive feature of erysipeloid is its purplish red color. The periphery of the infection is sharply defined, slightly elevated, and tense. In rare instances, erysipeloid manifests itself as an acute and fatal septicemia. Generalized joint pains have also been described in the more unusual infections. Pain, throbbing and burning in character, is the most common subjective symptom.

Recently Klauder,[89] reporting a series of 100 patients with Rosenbach's erysipeloid, called attention to the rather frequent occurrence of the disease in abattoirs and fisheries. Most of our patients were student veterinarians and their instructors who had received their infections from horses. Abrasions and cuts, usually on the hands, accounted for the focus of the infection in most instances. The first symptoms, pain, erythema and swelling, frequently became manifest within several days.

Of utmost importance in the treatment of erysipeloid is fixation of the affected member. Unless immobilization is complete, the infection continues to spread in spite of local therapy. Heat, wet or dry, immune serum, local antiseptic solutions, foreign protein injections and ultraviolet light have been favorably recommended. In our experience, and in the experience of others,[101,161] irradiation has been of unquestionable value (Table IX).

Before institution of roentgen therapy, the infected limb is splinted and supported

TABLE IX

ERYSIPELOID

Total number—21 cases

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect
Number of patients	17	1	3
Results	80%	5%	15%

in a sling. As a rule, 125 to 175 r, using Technique II or III, is directed to the infection, care being taken to go well beyond the periphery of the lesion (Fig. 6). The treatment is repeated in twenty-four to forty-eight hours, depending upon the appearance of the infection. Two to four or five exposures usually suffice, the infection being controlled usually within one week, the course without irradiation being ten to thirty days. Whether local applications enhance the value of irradiation is questionable.

The joint manifestations of erysipeloid, though rare, may also be treated with roentgen rays. Doses of 100 to 125 r, using Technique IV, repeated daily for two or three treatments, usually control the pain. Complete immobilization of the affected joint during and for several days after irradiation is essential.

FURUNCLE

A furuncle, or boil, is an infection caused by staphylococci which have reached the dermis by way of a hair follicle or sweat gland. It consists of a central area of inflammation which eventually becomes necrotic to form a slough (core). Although of minor importance in simple forms, furuncles are capable of severe and serious complications such as cavernous sinus thrombosis and septicemia.

TABLE X

FURUNCLES

Total number—117 cases

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect
Number of patients	85	12	20
Results	72%	10%	18%

In view of fundamental similarities between carbuncles and furuncles, it is not surprising that their treatment is comparable. As previously indicated, care must be taken to exclude diabetes and other chronic diseases. The general health of the patients should be evaluated and proper steps taken for supportive therapy. Though the infection is usually self-limited, proper precautions for preventing the spread of the disease must be taken. Patients with lesions near the mouth and nose should be warned against talking. If necessary, the mouth should be sealed with adhesive tape. Free use of parenteral fluids should be resorted to to maintain caloric and electrolytic requirements. In removing superfluous hair around furuncles, care should be taken to avoid skin abrasions[81] which serve as possible foci for spread of the infection. Proper cleansing of surrounding skin with green soap and mild antiseptics is as essential as treatment of the furuncle itself.

With few exceptions, most furuncles disappear regardless of the kind of treatment used. Baensch's[4] recent report, however, seems significant. In analyzing results obtained in 206 patients with furuncles on the face, half of whom received irradiation, the author found a 2 per cent mortality in the irradiated group compared with a mortality of 10 per cent in the group receiving the accepted forms of treatment excluding irradiation. Comparative therapeutic results of this type being scarce, one can only judge the efficacy of irradiation in infections by observing (1) the rapidity of the cure, (2)

TABLE XI

FURUNCLES

Total number—117 cases

Results obtained by irradiation in various portions of the body

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect
Head and neck	71*	8*	5
Body	5	1	3
Axilla	4	—	11†
Extremities	5	3	1

* Total of 79 patients helped by irradiation, 93 per cent.
† Poorest results obtained in this group.

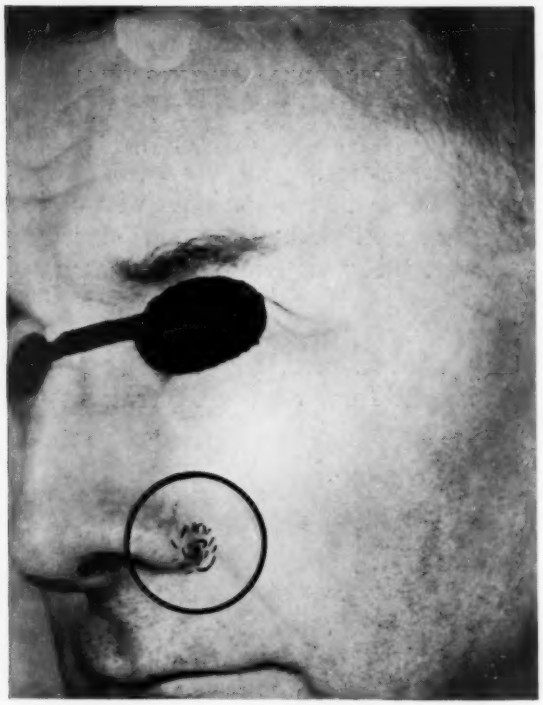

FIG. 7. *Furuncle, nasolabial fold.* Portal extends about 3 cm. beyond the area of induration. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 1–5 mm. Al filtration.

1st day—150 r 3rd day—100 r
2nd day—125 r 4th day—no treatment
5th day—100 r if necessary

the degree of scarring, and (3) the comfort of the patient.[88]

Most authors agree[4,26,50,74,81,88,114,169] that all the above criteria are favorably satisfied by radiation therapy. In analyzing our records (Table x), we attempted to evaluate results on the basis of these standards. Our most encouraging effects were obtained in lesions of the head and neck (Table xi). Our poorest results were in axillary furunculosis. This is in distinct contrast with Fried's[50] results which were best in the axillary group (95 per cent). We have been unable to account for this difference. Perhaps the use of an airplane splint for fixation of the parts might improve our results.[81]

The type and quantity of radiation employed is determined by the character of the lesion. All superficial therapy techniques have been used, Technique v (Fig. 7) being especially suited to infections around the eyes. The dose may vary from 75 to 200 r. When treated early, before complete fixation, furuncles may wholly regress without central necrosis after a single application of the radiation. Later, a stab incision for drainage may be necessary. We have the impression that the duration of the infection in the late cases may be shortened 50 per cent by roentgen therapy.

GAS GANGRENE

The most common etiological organism in gas gangrene is a gram-positive spore-forming anaerobe, *Clostridium welchii.* Found particularly in manure, it has an almost universal incidence.

If the possibility of gas gengrene is borne in mind, the diagnosis is not difficult. Severely contused wounds, compound fractures, and amputations in diabetics are unusually susceptible to this infection. The characteristic "mousy odor," brownish discoloration of the skin, signs of sepsis with pulse rise out of proportion to the temperature are characteristic. If, to these symptoms, one adds the roentgen manifestations of gas, or crepitation, the diagnosis is almost invariably established.

Early diagnosis being essential for low mortality, the roentgen diagnosis of gas gangrene assumes considerable importance. In suspected cases, some physicians examine the part roentgenographically at six hour intervals.[39] The earliest signs of gas usually appear near the wound of entrance. Small bubbles gradually form under the skin and extend along the fascial planes of the subcutaneous tissues and muscles. This gas must be differentiated from air carried into the wound during the injury and by hydrogen peroxide. It must be remembered that all gas forming organisms are capable of producing gas in tissues. None produce gangrene, however, except *Clostridium welchii.* Unless Welch bacilli are recovered from the inflammatory lesion, a positive diagnosis of gas gangrene cannot be made.

Prevention of gas gangrene is of prime importance in handling soiled wounds. Early debridement will protect many pa-

tients from the Welch bacillus. With the recent advent of serum, more conservative surgery is being practiced except where the blood supply has been interfered with. Dakin's solution, probably the most popular of antiseptics, is gradually being superseded by more acid solutions. Hydrogen peroxide, potassium permanganate, and mechanical devices for bubbling oxygen through wounds still enjoy wide popularity. Roentgen radiation is probably the newest therapeutic agent.

Kelly and his coworkers,[83,84,85,86] and others[5,42,43,63] have reported excellent results with irradiation which have been questioned.[39] Kelly, Dowell, Russum and Colien,[86] reporting 143 patients irradiated for gas gangrene, observed that patients operated upon for this infection did not fare so well as those in whom irradiation alone was used. These men found that of 33 patients in whom amputations were done, 3 died, a mortality of 9.1 per cent. In the non-amputated group of 72 patients, treated with irradiation, 3 died, a mortality of 4 per cent. Of added significance is the fact that of 18 patients with gas gangrene of the abdomen, reported by Kelly, Dowell, Russum and Colien, 14 recovered following roentgen therapy. Wide debridement or amputation being impossible in the latter group, the authors point to it as further evidence against radical surgery for gas gangrene when adequate roentgen therapy is available.

In attempting to explain the beneficial reactions observed in patients irradiated for gas gangrene, Faust called attention to the fact that roentgen rays produce small quantities of hydrogen peroxide in tissue fluids which might have a lethal effect upon the anaerobic Welch bacillus.[42,43]. Hydrogen peroxide being rapidly absorbed, this author suggested frequent treatments. Kelly[84] postulated changes in the toxicity of the gas as the result of ionization produced by radiation.

We have been unable to find experimental data in the literature to support the use of roentgen rays in gas infections. Kelly, *et al.*,[86] using guinea pigs, were unable to reproduce experimentally his excellent clinical results. They attributed the poor results to species differences. We have recently had similar experiences.

Fig. 8. *Gas gangrene.* Portal extends well beyond the involved area. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 5 mm. Al filtration.

1st day A.M.—75 r 1st day P.M.—75 r
2nd day A.M.—75 r 2nd day P.M.—75 r

Erb and Hodes[41] used pigeons as they were found to be excellent for laboratory purposes and the lesion was quite similar to that occurring in human patients. An attempt was made to determine the relative therapeutic value of specific serum, sulfanilamide, pre-injection irradiation, post-injection irradiation, and the combination of serum plus irradiation in the treatment of gas gangrene. The experiments were carried out in groups of 25 pigeons which included a proper control group, 150 birds being used.

Briefly, the results indicate that in the pigeon, roentgen irradiation is of no value in the treatment of *Clostridium welchii* infections. Sulfanilamide also proved valueless. Of all the therapeutic methods employed, serum alone proved beneficial. The combination of serum plus roentgen irradiation proved less effective than serum used alone.

In interpreting these results, one must bear in mind that (1) the experimental infection was monobacterial and not con-

FIG. 9. *Granuloma pyogenicum.* Portal very close (1 mm.) to confines of lesion. Outline of average treatment: 50 kv., 4 ma., 3 cm. skin-target distance, 0.2 mm. nickel filtration.

1st day—300 r	8th day—300 r
4th day—300 r	12th day—300 r

taminated by the common pyogens one usually finds in human infections; (2) a species difference may exist.

We have treated only 3 patients suffering from gas gangrene, 2 of whom died. It is fair to state that the deaths occurred in patients *in extremis* at the time irradiation was employed.

There are no contraindications to roentgen therapy in gas gangrene. Roentgen rays generated at voltages varying from 100 to 200 kv. have been used successfully. According to Kelly,[88] doses of 100 r repeated once or twice at twelve hour intervals are sufficient in suspected cases for prophylaxis. In well developed cases, Kelly used similar doses at twelve hour intervals over a period of three to five days with equal success. Care must be taken to go beyond the confines of the lesion and to use rays of sufficient energy to assure an adequate depth effect (Fig. 8).

An analysis of the data available in connection with the roentgen treatment of gas gangrene indicates that the earlier patients are irradiated, the better the prognosis. Kelly and his associates believe that the time to treat gas gangrene is before it develops, that is as a prophylaxis in the suspected case. The procedure is simple and, when directed by an experienced roentgenologist, can do no harm. Indeed some surgeons* are taking the precaution of treating all compound fractures with roentgen rays to prevent subsequent infections and gas gangrene.

GRANULOMA PYOGENICUM (TELANGIECTATICUM)

This affection is characterized by a small pedunculated or sessile tumor which is usually the result of a staphylococcic infection following trauma. Microscopically, the lesion consists of granulation tissue, young connective tissue cells, and many newly formed blood vessels. Indeed, vascularization may be excessive enough to suggest an angioma.

Typically, the small tumors in granuloma pyogenicum grow rapidly. Varying in size from a grain of rice to the size of a cherry, the lesions are usually moist and fleshy. They bleed easily and freely. At times, the surface is ulcerated and bathed in purulent secretions. Smooth surfaces with crevices filled with pus are equally common.

In the past, these lesions have been excised surgically or burned off with the cautery. Unless carefully removed, they tend to recur. Because of this and in view of superior cosmetic results, irradiation is now being used for pyogenic granulomas by many men[2,74,106] (Fig. 9).

We have treated 6 patients having pyogenic or telangiectatic granulomas, obtaining an excellent result in each instance. The total amount of radiation applied to the skin varied from 300 to 2,000 r, depending upon the size and duration of the lesion. When treated early, irradiation with 600 r, using Technique III or V, produces the de-

* Dr. Albert Bowen has used this form of prophylactic irradiation for compound fractures with considerable satisfaction (personal communication).

sired result. Lesions of longer duration may be treated with doses of 300 r twice a week until the tumor becomes about one-fifth its original size. The continued effects of the radiation previously received will ultimately produce a small punctiform scar at the attachment of the pedicle.

HERPES SIMPLEX

This acute skin disorder is characterized by the appearance of vesicles on a mild erythematous base.[103] The etiology is still obscure though the evidence suggests that the vesicles contain a living agent or a virus.

Herpes simplex commonly involves the face. The lips, nose, cheeks and ears are the favorite sites. The first symptoms of herpetic infections are burning and stinging sensations. These are soon followed by a wheel-like lesion studded with millet-sized vesicles. Within several days, the lesions become seropurulent and rupture to form a light crust under which healing occurs.

Numerous remedies have been advocated to abort or cure herpes simplex. Wet dressing of 1 per cent aluminum acetate or hot water sponges, followed by spirits of camphor or lotio alba, have been used successfully.[103] Others have used powdered alum, alcohol, and camphor water with equal benefit. Frequent applications of tincture of benzoin used after the vesicles rupture may prevent secondary infection and suppuration.

In 1938, Hall[62] reported gratifying results following roentgen therapy for herpes simplex. Since then, we have treated 11 patients with equally encouraging findings. All of our patients with one exception were definitely benefited by irradiation. The lesion in the latter, involving the conjunctiva of the eye, was not influenced by roentgen therapy.

As a rule, 125 to 175 r, using Technique V, repeated daily for two or three treatments suffices to control the infection. Occasionally, burning and biting sensations cease within twelve hours following exposure. The vesicles dry rapidly. The usual course of the disease is shortened considerably (Fig. 10).

Fig. 10. *Herpes labialis*. Portal extends 1 cm. beyond lesion. Outline of average treatment: 50 kv., 4 ma., 3 cm. skin-target distance, 0.2 mm. nickel filtration.

1st day—150 r
2nd day—150 r
3rd day—no treatment

PAROTITIS

By far the most common organism found in acute parotitis is *Staphylococcus aureus* which occurs in about two-thirds of the cases.[129] The preponderance of this organism in these infections has been partially explained by Siefert,[149] who demonstrated an increase in staphylococci in the mouth during all conditions which dry its mucosa. Further bacteriological studies of saliva taken from patients before and after operation revealed abnormal increases in the staphylococcal content of the mouth which lasted three to four days. The most marked changes were noted in fasting patients or in patients with dry mouths.

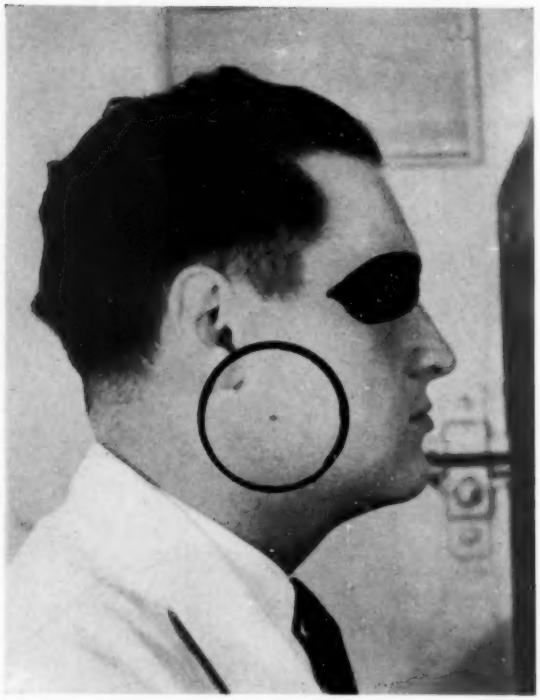

FIG. 11. *Acute postoperative parotitis.* Portal extends about 5 cm. beyond area of induration. Outline of average treatment: 120 kv., 5 ma., 30 cm. skin-target distance, 0.25 mm. Cu plus 1 mm. Al filtration.

1st day—125 r 3rd day—100 r
2nd day—150 r 4th day—no treatment
5th day—100 r if necessary

Theoretically, infections may reach the parotid by (1) direct extension from adjacent infected tissues, (2) hematogenous invasion in septicemias, or (3) as the result of an ascending infection via the duct. Acute postoperative infections of the parotid are almost always ascending in origin. In the earliest stages, it consists of a catarrhal inflammation which may plug the duct, interfering with free exit of saliva into the mouth. If the obstruction persists or if the organisms continue to multiply, minute abscesses develop in the smaller ducts and alveoli. The final stage consists of the fusion of many of these small abscesses with the formation of a diffuse suppurative parotitis.

The incidence of acute postoperative parotitis in the Hospital of the University of Pennsylvania is about 0.1 per cent.[9] As a rule, the condition develops during the first week. Pain in the region of the jaw or in the ear, slight swelling, and a moderate degree of fever with corresponding elevations in the pulse rate are the earliest symptoms. The orifice of the parotid duct may be inflamed and ooze mucopus with pressure over the gland. As the infection progresses, the gland becomes more swollen and exquisitely tender. Constitutional disturbances and delirium are not uncommon in the severe cases.

For treatment to be efficient, the diagnosis must be made early and active measures immediately instituted to overcome the obstruction in the duct. Massage of the parotid in a forward direction is the most certain means of overcoming ductal obstructions. As long as the duct and alveoli can be emptied, serious local extensions of the disease rarely take place. Whenever necessary, the duct should be probed or syringed to initiate salivary flow.

Chewing, especially solid foods, provides the most active stimulus to salivation. For the same reason, patients should be forced to chew gum between meals. The free use of acid beverages helps considerably. Heat affords patients with parotitis considerable relief of pain and encourages parotid emptying. More recently, irradiation has been tried with considerable success[28,33,74,91,142,160] (Table XII).

TABLE XII

PAROTITIS (ACUTE POSTOPERATIVE)

Date	Author	Number of Cases	Result: Percentage Benefited
1936	Knüpper and Hummel[91]	32	78
1936	Robinson and Spencer[142]	12	83
1937	Decker[28]	10	80
	Present series	27	60

We consider irradiation of acute parotitis a radiological emergency as our best results have been obtained in cases treated immediately after the diagnosis was made. In most instances, 125 r, using Technique III

or IV, is delivered to the skin surface (Fig. 11). The pain frequently subsides after the first treatment. Usually two to four exposures, given at twenty-four hour intervals, suffice to control the infection, providing free drainage from the parotid duct has been secured and maintained (Table XIII).

TABLE XIII

PAROTITIS

Postoperative group—27 cases

	Rapid Improvement	Normal Course Shortened Moderately	Little or No Effect	Died
Number of patients	14	2	3	8*
Results	52%	8%	11%	29%

* Four of the 8 patients who died were moribund when roentgen treatment was first given.

It is well to warn the attending physician and the patient that dryness of the mouth, which is present so frequently in these patients, is not due to the irradiation but to the associated fever which these patients often have. Unless this is done, the uninformed physician may attribute the dryness to the irradiation. Surgical drainage was resorted to in almost 20 per cent of the patients we irradiated. When this was necessary, the judicious use of small doses of radiation (75 to 100 r) served to hasten resolution and healing.

We have had a limited experience in treating recurrent and chronic parotid infections. These conditions form clinical entities almost as well defined as the acute postoperative group. Patients with the recurrent infection usually date the onset of the disease from an upper respiratory infection. Occasionally, it develops as a late complication of an acute parotitis. The condition is characterized by recurring bouts of parotid swelling, pain, and a somewhat turbid and flaky saliva.

Chronic parotitis is less common than either the acute or recurrent infections. Usually associated with parotid calculi, it may be the local manifestation of a systemic disease.

Results following irradiation in recurrent parotitis and non-calculous chronic parotitis are comparable to the results obtained in the acute form. As a rule, 125 to 175 r, using Technique III or IV, given over the involved gland two or three times a week produces the desired improvement. Only six to eight treatments may be necessary.

PNEUMONIA

In 1907, Edsall and Pemberton*[38] called attention to the beneficial reaction produced by irradiation in delayed pneumonic resolution. Since then, other favorable reports have appeared in the literature.[94,112,137,158] The roentgen treatment of acute pneumonia, however, is relatively recent, the earliest reports by Heidenhain and Fried[47,66] being published in 1924. In

* Dr. H. K. Pancoast treated these patients for the authors in 1906.

TABLE XIV

PNEUMONIA

Date	Author	Number of Cases	Mortality Percentage
1927	Fried[50]	40 (postoperative)	80
1937	McIntire and Smith[107]	34	14 bronchopneumonia 9 lobar pneumonia
1939	Powell[136]	135	13 bronchopneumonia 5 lobar pneumonia
1939	Scott[148]	138	15 bronchopneumonia 22 lobar pneumonia
1939	Solis-Cohen and Levine[151]	42	20 adults 22 children

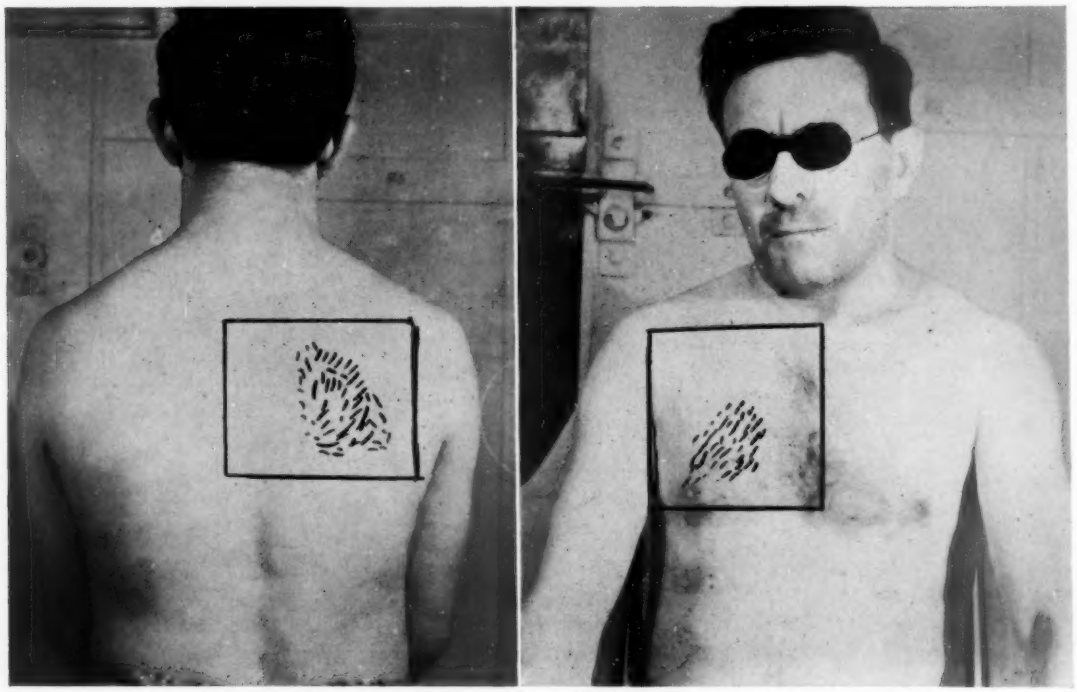

FIG. 12. *Pneumonia.* Portal goes well beyond the area of pneumonic consolidation. Outline of average treatment: 200 kv., 15 ma., 50 cm. skin-target distance, 0.5 mm. Cu plus 1 mm. Al filtration.

1st day—150 r anteriorly
2nd day—150 r posteriorly
3rd day—100 r anteriorly
4th day—100 r posteriorly

1926, Fried[49] recorded the first sizable group of patients (40) with acute pneumonia receiving roentgen therapy with complete recovery in 80 per cent of the series. Several years later, the same author reported excellent results following irradiation in 57 children with bronchopneumonia.[52]

McIntire and Smith[107] and Powell[135,136] are largely responsible for the recent interest in roentgen therapy in pneumonia in this country. Powell's series of 231 patients irradiated for pneumonia with a mortality of 7 per cent is probably the largest series on record at the present writing (Table XIV).

Experimental data supporting the use of irradiation in pneumonia are scant. Fried[55] irradiated guinea pigs after the artificial induction of pneumonia and found that after using doses of 90 to 95 r (160 kv., 30 cm. skin-target distance), hepatization was less solid in the irradiated animals. Microscopically, there was less congestion, edema, and cellular infiltration noticed in the treated lungs.

Some authors[30,134] state that the beneficial results produced by irradiation in pneumonia are due to the direct effect of roentgen rays upon the leukocytes. According to Fried,[49] however, the beneficial effects are the result of increased general immunity following irradiation and local vasodilatation.

Current investigations in our department seem to support the value of roentgen irradiation in experimental pneumonia in dogs.[72] Using virulent Type I and Type III pneumococci, artificial pneumonia was induced in approximately 50 dogs. One group of animals was used as control; the sicker animals were treated with irradiation. The average duration of life and the number of animals surviving was greater in the irradiated group than in the control series. The dramatic results reported in humans follow-

ing irradiation were not obtained in the dogs. It is fair to state that the dogs in this experiment were probably much sicker and had a higher incidence of positive blood cultures than in any series of humans thus far reported.

The first series of animals was treated with roentgen rays generated at 80 kv., with 1 mm. of aluminum as a filter, at a distance of 30 cm., using one lateral field on the side of the lesion (20×20 cm.). Doses of 105 to 135 r were used at twenty-four hour intervals for two or three treatments. Only one animal survived the pneumonia. This animal had been irradiated. The average duration of life in the irradiated and untreated groups that died was approximately the same.

The second series of animals was treated with roentgen rays generated at 200 kv., with 0.5 mm. of copper plus 1 mm. of aluminum filtration, at a distance of 50 cm., using the same lateral portal (20×20 cm.). Doses of 160 to 200 r were delivered to the skin daily for two to four days. All the control animals died in about two days. The average duration of life in the irradiated group that died was about nine days. Six of the 14 animals treated recovered.

We are now comparing the results of sulfapyridine with irradiation in another series of pneumonic dogs. The series is still too small to permit conclusions to be drawn.

Our personal experiences in the roentgen treatment of pneumonia are limited. In hospitals where irradiation is practiced as a routine, the patients are taken to the department of radiology for diagnosis and treatment before being admitted to the hospital. In most instances, 200 to 350 r is delivered to the skin, using Technique III, IV or VI, the dose being repeated in twenty-four to forty-eight hours. When effective, patients with lobar pneumonia obtain marked relief within twelve hours after the first exposure. The temperature usually drops by crisis, with a coincidental drop in the white blood count, pulse, and respiration (Fig. 12).

The response of patients with bronchopneumonia to radiation therapy seems variable. This may be due to the fact that so many stages of the disease are present at the same time.[136] McIntire and Smith[107] believe that patients with bronchopneumonia should first be treated with diathermy for forty-eight hours to allow stabilization of their lesions. In their experience, stabilized bronchopneumonia responds as well to roentgen therapy, as does lobar pneumonia.

With the rapid development of chemotherapy in the treatment of pneumonias, radiologists treating pneumonias should direct their attention particularly to those pneumonias which do not, as a rule, respond to chemotherapy. Powell's[136] most recent experience indicates that Type III pneumonias respond very well to roentgen therapy.

SINUSITIS

In 1923, Osmond[125] called attention to the value of irradiation in the treatment of sinusitis. Since then, numerous reports have been published (Table XV) attesting to the fact that irradiation is a simple and safe therapeutic measure offering excellent results in a rather large percentage of patients.[11,75,78,127,139,140,150] The experimental data recorded by Butler and Woolley[11] are as follows: After inducing streptococcic infections in one of the frontal sinuses in a series of cats, these authors irradiated the sinuses with single doses of 800 to 1,600 r, a third group of infected animals serving as

TABLE XV
SINUSITIS

Date	Author	Number of Cases	Result: Percentage Benefited
1923	Osmond[125]	12	100
1934	Butler and Woolley[11]	450 (not allergic)	91
1937	Rathbone[139]	70 (children)	85
1937	Koch[92]	67	68
1938	Smith and Nickel[150]	25	56
	Present series	98 (adults)	42
	Present series	42 (children)	92

controls. All of the animals were then sacrificed and the frontal sinuses examined microscopically. Comparison of the treated and untreated animals revealed a greater number of macrophages in the mucous membranes of the treated sinuses which, in addition, seemed to contain fewer lymphocytes.

Koch,[92] operating upon patients in whom unilateral irradiation had been given for sinus disease, observed the mucous membrane on the treated side to be thinner and more compact than on the untreated side. When operated upon early, however, the edema was more marked in the irradiated sinus. The author commented upon the greater ease of operating in the irradiated field. Koch confirmed Butler and Woolley's observations pertaining to the cellular elements present following roentgen therapy and, in addition, called attention to marked capillary dilatation.

TABLE XVI

SINUSITIS—INFANT GROUP
Total number—24 cases

	Complete Relief of Symptoms	Moderate Relief of Symptoms	Little or No Relief of Symptoms
Number of patients	20	2	2
Results	84%	8%	8%

Of paramount importance in the roentgen treatment of sinusitis is the maintenance of adequate drainage. Unless drainage is free, irradiation may be attended by severe local reactions and septicemia. Most radiologists prefer, therefore, to relegate the treatment of acute sinus infections to others though Koch has used irradiation in the acute stage with good results.

As a group, sinus disease in children usually responds much more favorably than in adults. Properly employed, irradiation frequently avoids the complications of sinusitis such as adenitis, otitis media, and mastoiditis. Recurring head colds, cough, and nasal discharge are common complaints in children with prolonged sinus disease. Usually associated with low grade fever, the condition has commonly been confused with pulmonary tuberculosis. In others, otitis media, mastoiditis, and adenitis have been the only manifestations of sinus disease. Direct examination of the upper air passages in these children almost invariably reveals diffuse lymphoid hyperplasia and large adenoids. Roentgen evidences of mucuous membrane thickening in the ethmoidal and maxillary sinuses are common findings. Roentgenograms of the chest of children with bronchosinusitis may or may not reveal increased prominence of the hila and bronchovascular markings.

In our experience, the quality of radiation used is of no significance providing the depth dose is adequate. As a rule, Technique IV or VI is employed. The eyes and eyebrows are protected with 1 mm. lead shields. One anterior, two lateral and two posterior portals are used (Fig. 13). The anterior portal extends from the middle of the brow down to the upper lip. The lateral areas extend from the tragus of the ear to the lateral corner of the mouth and eye. The posterior portals are directed through the mastoid region in a plane directed into the posterior ethmoidal and nasopharyngeal regions. The treatments are given daily over a period of about six days, treating one portal per day in rotation with 50 to 75 r applied to the skin. When effective, the fever subsides almost immediately after the first exposure. Within twenty-four to forty-eight hours, the character and quantity of the nasal discharge change. In some instances, especially in infants, suction may be necessary to keep the nasal pathways

TABLE XVII

SINUSITIS—ADULT GROUP
Total number—98 cases

	Complete Relief of Symptoms	Moderate Relief of Symptoms	Little or No Relief of Symptoms
Number of patients	23	19	56
Results	24%	19%	57%

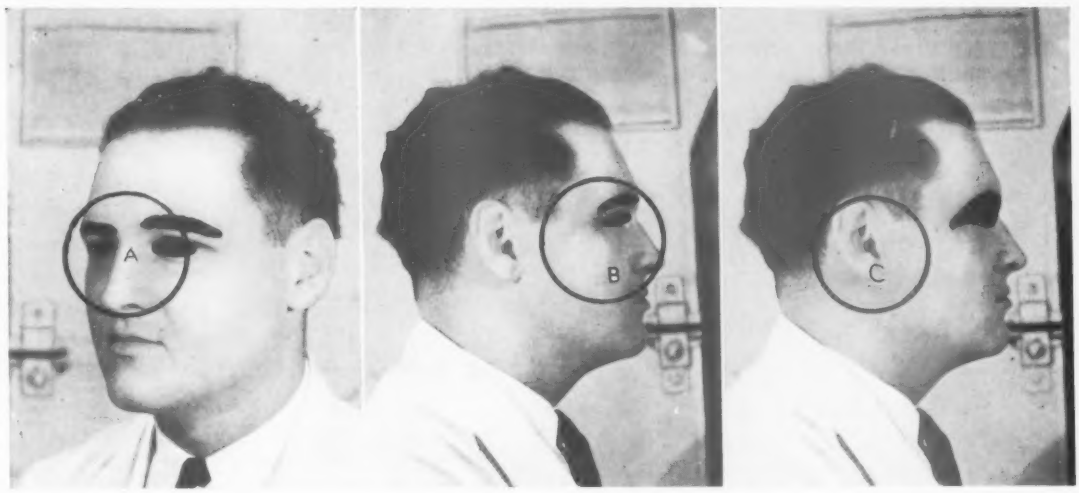

Fig. 13. *Sinusitis.* Portal *A:* As a rule, a 12 cm. portal suffices to cover all of the sinuses. Lead pieces protect the eyebrows and orbits.

Portal *B:* Lateral portal covers sphenoidal sinus in addition to ethmoidal and maxillary sinuses.

Portal *C:* Directed into sphenoid sinus and nasopharyngeal lymphoid tissues. The ethmoidal sinuses and maxillary sinuses are partially included.

Outline of average treatment (adult and child): Note the lead protection to the eyes and eyebrows 200 kv., 15 ma., 50 cm. skin-target distance, 0.5 mm. Cu plus 1 mm. Al filtration.

1st day—50 r—Portal *A*
2nd day—50 r—Portal *B* right
3rd day—50 r—Portal *C* right
4th day—50 r—Portal *B* left
5th day—50 r—Portal *C* left
6th day—50 r—Portal *A*

open. The child's appetite improves. Cough almost invariably disappears within one week to ten days following irradiation. Unless these favorable signs ensue rapidly and the sinuses become clear roentgenographically, the child should be investigated for allergy (Table xvi).

The results following roentgen therapy in adults (Table xvii) with infections of relatively short duration have been comparable to the results obtained in children. Long-standing chronic infections, however, respond less favorably.

Adults with chronic sinusitis frequently complain of recurring colds which are, in reality, acute exacerbations of a chronic disease. Post-nasal drip, cough, and general facial distress are often present. Toxemia, neuralgias, especially facial, occipital, and trigeminal neuralgias, and foul breath are also relatively common complaints.

The objective findings in these patients are usually definite. Injected, swollen turbinates with evidence of pus coming from ostia are common findings. Tenderness on pressure over infected areas and abnormal shadows upon transillumination are also frequently encountered. Of equal importance are the roentgenographic manifestations of sinus disease. The presence or absence of atrophic and hypertrophic bone changes, mucous membrane thickening, polyps, cysts, and fluid levels guide one considerably in determining proper therapeutic methods. Patients with retained secretions are rarely irradiated until proper drainage has been established lest complete occlusion of a sinus develop exposing the patient to severe local reactions, retrograde thrombophlebitis, and septicemia.

In our experience, patients with roentgen evidence of atrophic bone changes or condensing osteitis respond poorly to irradiation. Allergic sinusitis also resists roentgen therapy unless there exists a superimposed bacterial infection. This type of sinus disease may be identified by the presence of polyps in the nose or in the films of the

sinuses, by the presence of eosinophiles in nasal smears, and by a careful history. Patients known to have or suspected of having allergic sinus disease are immediately referred to an allergist for diagnosis and treatment. In such instances, roentgen therapy for a superimposed sinus infection is only considered after the allergic sinus manifestations have been controlled. It has been interesting to note that many of the patients sent to us for treatment of chronic sinusitis who obtained little or no benefit were subsequently found to have an allergic sinusitis. Our best results in the treatment of chronic sinusitis seem to occur in patients whose roentgenograms reveal enough mucous membrane thickening to encroach upon the lumen of the sinus forming a small central radiolucent cavity.

Schenck[146] recently observed that large doses of iodides enhance the resorption of fibrous tissue from chronic lymphoid tufts in the oral pharynx. Based upon these observations, Schenck suggested that roentgen therapy might prove beneficial in a greater number of patients if it were used in conjunction with iodides. Following this suggestion, we now give all patients referred for irradiation of sinus disease iodides for a period of one week to ten days prior to exposure. We have used lipoiodine ($4\frac{1}{2}$ grains, Ciba) which is a palatable form of iodine, the patient taking one tablet three times a day. Saturated solutions of potassium iodide are equally effective and considerably less expensive. We are careful not to prescribe the drug in patients known to be sensitive to iodides or in thyrotoxic individuals. Occasionally, a rash or excess salivation appears as a manifestation of iodide toxicity.

The roentgen therapy of patients with chronic sinusitis is comparable to the course of treatments outlined above in children. Whenever necessary, the series of exposures is repeated once in six to eight weeks.

VERRUCAE

The common term applied to these small papillary growths is "wart." These lesions present a pedunculated or sessile base with a flat or pointed hyperkeratotic top. Pathologically, verrucae are characterized by marked thickening in the stratum corneum of the epidermis. The evidence seems to suggest they are of virus origin.

Dermatologists recognize four types of verrucae:[2,123]

1. *Verruca Vulgaris.* Occurring most commonly on the hands and fingers of children, these lesions consist of smooth horny elevations of the skin which may be gray, yellowish, brown or black in color. The older lesions become roughened, presenting minute papillary projections.

2. *Verruca Plantaris.* These lesions occur most often upon the soles of the feet, though the hands are occasionally involved. They may be single or multiple. Plantar warts almost invariably involve points of pressure where they assume the appearance of a callus with corn-like excrescences. Pain, especially on pressure, is their chief symptom.

3. *Verruca Plana Juvenilis.* This type of wart is also common in children, occurring on the face and hands. They are much more numerous than verruca vulgaris and have a greater tendency toward symmetrical distribution.

4. *Verruca Acuminata.* These lesions involve the moist folds about the genitals and anus where they appear as macerated condylomata.

Numerous caustics have been used with varying success in the treatment of verrucae. Among these may be listed salicylic acid, glacial acetic acid, trichloracetic acid and chromic acid. Carbon dioxide snow and electrolysis have also produced good results. Recent reports pertaining to the effects of irradiation upon verrucae have been unusually encouraging.[97,98,132]

We have treated 208 patients with plantar warts. The incidence was slightly higher in males (55 per cent) compared with females (45 per cent). Almost 65 per cent of the lesions occurred on the feet, 35 per cent involving the hands. In our experience, the majority of patients with warts on the feet

presented themselves for treatment in the spring and early fall. This seasonal tendency has suggested that changes in the styles of shoes in the spring and fall produce unusual pressure upon the feet which may account for most cases of verruca plantaris. Unless proper shoes or supports are

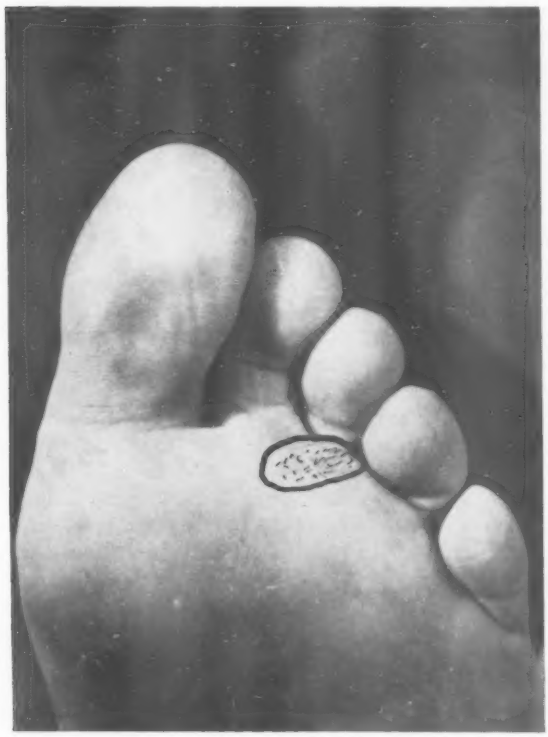

FIG. 14. *Plantar wart.* Lead portal cut to fit each individual. A narrow border (about 2 mm.) of normal tissue is allowed around the lesion. Outline of average treatment: 50 kv., 4 ma., 3 to 5 cm. skin-target distance, 0.2 mm. nickel filtration; 2,500–3,000 r at one sitting.

employed to relieve this irritation, treatments for plantar warts are not very satisfactory.

Pohle[132] has recommended doses of 410 to 680 r, using low voltage radiation, for the treatment of plantar warts. In our experience, 2,000 to 2,500 r delivered to the skin surface at one time has produced an excellent result in 98 per cent of the cases. Careful shielding of the surrounding tissue and limitation of the exposure to the wart alone are imperative when large doses are employed. Low voltage radiation using little filtration and the shortest possible target skin distances is ideal for treating warts (Fig. 14). We use rays generated at 50 kv. (Chaoul apparatus) which are filtered through a filter equivalent to 0.2 mm. of copper at a target skin distance of 3 to 5 cm. The desired dose is delivered in about eight minutes. The reaction which reaches its peak about eighteen to twenty-one days after exposure is limited to the outer 3 to 5 mm. of skin. A sponge rubber cushion to protect the erythematous site affords considerable relief during the period of reaction, which may last a week or ten days. In most instances, healing is complete and the verruca entirely removed within six weeks following exposure.

In those patients who have had previous roentgen or radium treatment and in some who have been operated upon, one should be very careful about suggesting further roentgen therapy because of the danger of producing a chronic ulcer. Two possible explanations for chronic ulcers in such individuals may be limitation of blood supply to the part and there may be an unusual irritation to the area resulting from improper shoes.

SUMMARY

1. We have reviewed the physiological responses to irradiation which may be of significance in the treatment of inflammations.

2. We have suggested that the vascular responses to irradiation are very important in this form of therapy.

3. We have surveyed some of the literature dealing with the roentgen treatment of inflammations and have attempted to bring together in tabular form some of the results reported by others.

4. We have analyzed our records and have reported our results in the treatment of inflammations with roentgen rays.

5. We have described in detail the technique we employ in the treatment of different inflammatory conditions.

6. We have attempted to stress the importance of considering roentgen therapy

but one step in the treatment of inflammations. Nature's inherent protective mechanisms are probably of more importance and must be maintained by adequate supportive measures if the best interests of the patient are to be served.

We wish to acknowledge our indebtedness to Drs. Stuart Mudd and John S. Lockwood for their cooperation and criticism.

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A STATISTICAL STUDY OF LATE EFFECTS OF HEAVY ROENTGEN IRRADIATION ON HEALING OF SKIN WOUNDS*

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IN AN earlier communication[1] I reported on some effects of irradiation on tensile strength of experimental skin wounds. Acute sequelae of irradiation were investigated at that time. It was found that 300 roentgens given to skin wounds of white rats immediately after operation produced significant increase in the breaking or tensile strength of healing wounds. Larger doses of 1,020 r and 1,800 r resulted in definitely decreased wound tensile strength. Doses of 1,800 r produced the same decreased wound strength when given to the skin either one or three weeks before operation. The same amount of radiation given twenty-four hours after operation showed no significant effect on healing. Using the same method of investigation, another series of experiments was carried out in an attempt to study delayed irradiation effects.

METHOD

Thirty-nine adult, male, albino rats were given roentgen irradiation to a 4×1 cm. ventral skin field. The total dosage was 4,500 r administered in weekly fractions of 1,500 r each.

Roentgen rays were produced by a full wave, mechanically rectified generator, operated at 95 kv. (peak). With a Coolidge tube, using 4 ma. of current, at 25 cm. focal-skin distance, and without added filter, the output was 152 r per minute, measured in air.

Sixty days following irradiation a 4 cm. linear incision was made in the treated skin and a similar incision in normal skin. The wounds were closed with black silk sutures. At intervals of ten, twenty, thirty, and fifty days following operation, control and experimental wounds were excised and their tensile strengths determined by means of a thread tester. Curves of tensile strength were constructed for control and irradiated wounds. Ten animals were used for each point on the curves.

The method of statistical analysis of results was that described in detail in a previous report. The significance of results is expressed in terms of a probability value, *P*. Values exceeding 0.05 are not considered significant.

RESULTS

The wounds in skin which had previously received heavy irradiation showed considerable decrease in tensile strength as compared with control wounds. The difference between the two sets of wounds is of definite statistical significance (Fig. 1).

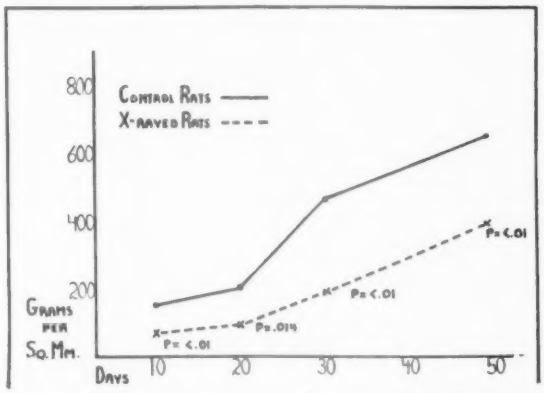

FIG. 1. Curves showing tensile strength of control and irradiated wounds. The value of *P* (see text) is indicated for each observation.

DISCUSSION

There has been a feeling among surgeons and roentgenologists that operative procedures done through skin which has been subjected to a large amount of radiation may result in poor wound healing. The present experimental findings seem to lend

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support to this impression. The wounds do heal, but the process is slow and the scar is unquestionably not as strong as normal scar tissue.

CONCLUSIONS

Roentgen irradiation of the skin of albino rats with 4,500 roentgens sixty days preceding operation results in interference with healing as determined by wound tensile strength.

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FIG. 1. The only known case of alpha-particle burn. The beam felt very hot, and the hand remained for only an instant. In spite of the short interval there was an extensive burn which lasted for about twenty days, and then fortunately healed completely.

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AN ERYTHEMATOUS SKIN REACTION PRODUCED BY AN ALPHA-PARTICLE BEAM

CASE REPORT

By JOHN C. LARKIN, M.D.
Crocker Radiation Laboratory, University of California
BERKELEY, CALIFORNIA

AN OPPORTUNITY to follow the course of an alpha-particle reaction was recently provided as a result of an accident. While working with the cyclotron, a graduate student inadvertently put his hand in a beam of 32 million volt alpha particles. This resulted in the only visible erythematous reaction caused by a beam of alpha particles on record.

For the production of certain transmutations in nuclear physics, alpha particles are used to supply the energy. The alpha particles are produced by accelerating ionized helium in the cyclotron. These particles are forced to travel in a circular path by a magnetic field, and on gaining momentum by falling through successive potential gradients produced by the alternating electrostatic fields take on a spiral course, and finally reach the periphery after about 40 revolutions. They then are deviated from their spiral course by a deflecting electrostatic field at the periphery and at this time have attained velocities equivalent to 32 million electron volts. However, due to their charge and mass they are able to penetrate only 75 cm. in air or about 1 mm. in tissue. They dissipate their energy very rapidly, and produce very dense paths of ionization a thousand times greater than the gamma rays. Because of this very low penetration in tissue, they are of no value in cancer therapy, but of the greatest value to the nuclear physicists. By using very thin windows the particles may be seen producing a blue fluorescent beam as they pass out and ionize the air. It was this beam that produced the erythematous reaction seen in Figure 1.

When the beam struck the student's hand he described the sensation as one of extreme heat, as if it were in a gas flame, and withdrew his hand as rapidly as possible. The time of exposure was estimated to be about one second. In four hours the area was erythematous, two small blisters appeared, but the original sensation of pain did not persist. The next day the area became painful and remained so for four days, but the erythematous reaction seemed to regress for the time being. By the tenth day there was desquamation of the stratum corneum, marked thickening of the skin, and the area was insensitive to touch. On the next day, he noted the area was again becoming erythematous, quite swollen, and again very sore. After eighteen days the erythematous reaction began to regress somewhat, but the thickening and roughening of the skin continued to progress. After six weeks the reddening of the erythematous reaction could not be seen, but even after four months there is still some thickening of the dermis.

One must conclude from this that in spite of the high energies of the alpha particles they were able to penetrate only into the corium, and did not reach the connective tissue and produce ulceration. If one calculates the heat produced from the 0.1 microampere beam of 32 million volt alpha particles with the estimated time of exposure one second, it is found to be less than one calorie, and could not possibly raise the temperature of the skin high enough to cause a burn. The only explanation of the sensation of heat is the possible stimulation of the sensory nerve endings in the skin giving the same sensation as heat, and is a problem for the nerve physiologist. A second calculation of interest is the number of roentgens produced, assuming all the energy is absorbed within the first millimeter of tissue and over approximately 32 sq. cm. of hand surface, and proves to be about 70,000 roentgens of ionization produced in this small area.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-sixth Annual Meeting: Hotel Cleveland Cleveland, Ohio, June 2–3, 1941.

EDITORIAL

WAR RADIOLOGY IN GREAT BRITAIN*

RADIOLOGISTS in the United States may be interested to know something of British roentgen-ray work in this war. The conditions of the present time are very different from those of twenty-five years ago, when there were very few experienced radiologists and apparatus was more or less primitive, unreliable and inefficient. The radiologist's first concern in those days was to obtain satisfactory roentgen-ray plates with the apparatus at his disposal. His ability was judged by the quality of the plates he produced rather than by his skill in interpretation. Primarily he had to be a technician. The work was chiefly concerned with fractures and with foreign bodies, for the localization of which each radiologist produced his own variant of the triangulation and parallax methods and was inordinately proud of it. He did a large proportion of the work himself, particularly the localization, until he discovered that some of this might be made a routine procedure that could be delegated to his assistants. There were few skilled technicians in those days, and each radiologist trained his own.

Today much of this is changed. Apparatus is efficient and relatively plentiful. Its efficiency is many times greater than that of any apparatus available at the time of the last war, when we anxiously watched the roentgen tubes for signs of overload and only too often had to break off an exposure before the necessary ten seconds to five minutes were completed. There is a good supply of skilled technicians, whose training covers not only the physics, instrumentation and technique of their subject, but also human anatomy. They are thoroughly competent to carry out all the technical work. The radiologist is, however, responsible for this and for the maintenance of the highest possible standard of roentgenography. The peculiar problems of trauma caused by falling masonry and by the freakish effects of blast must always exercise his ingenuity and resourcefulness in obtaining the requisite information with the minimum disturbance of the patient and in the avoidance of unnecessary suffering and shock. He must be ever on guard for pre-existing pathological conditions and for near and remote complications that may be unsuspected clinically and not suggested by the external wound. In dealing with injuries of the head, thorax, abdomen and spine particularly, he must always have adequate time at his disposal for detailed study and direction of technique. In short, the radiologist's work has become less and less concerned with the actual technique, and more and more with supervision and interpretation.

In making preparations for the threatened war, it was natural that the Army, in addition to maintaining regular military hospitals for routine work in this country, should provide the whole medical service for the overseas forces. The arrangements for this overseas service were based primarily on the experience of the last war. Standardization is the fundamental principle of all Army organization, and full-scale fixed sets were provided for the centralized base hospitals, semi-fixed sets for general hospitals, and mobile units for the casualty clearing stations. Ample reserves of units and spare parts were accumulated in depots. The casualty clearing station sets

* From a correspondent. London, November, 1940.

were so designed that the whole outfit could be repacked in a van (which also acted as a dark-room) and be ready to move off in less than half an hour. A specialist in radiology, with the rank of Major, and two graded technicians were attached to each unit. All through the winter of 1939–1940 the roentgen-ray work in the base hospitals overseas was of the ordinary civilian type, with a sprinkling of casualties sent back from the front line, while even in the casualty clearing stations there was little emergency work to test out the efficiency of the organization. In the spring of 1940, however, when the Germans pushed through, it became evident that the mobile conditions of modern warfare restricted the activities of the casualty clearing station, and there was little or no opportunity to use the carefully planned mobile units that had seemed so well suited to the needs of the casualty clearing station as they had been envisaged.

At home, arrangements had to be made for dealing not only with casualties from the fighting services from overseas, but also with the vast numbers of the civilian population that were expected to be injured in air raids. Consequently, an Emergency Medical Service was organized under the Ministry of Health, to deal primarily with civilian casualties and also with cases from the combatant forces when these were sent home. It was anticipated that the main civilian hospitals of the large cities would be very vulnerable, and therefore a vast scheme for the provision of new emergency hospitals was prepared. These emergency hospitals were, as far as possible, to be outside the vulnerable areas and the majority were to be housed in evacuated mental hospitals, poor law institutions, sanatoria, etc. In many cases groups of huts were to be added to existing institutions, and in some places new hospitals were planned. Certain of the emergency hospitals were earmarked as special centers for orthopedic, chest, and maxillo-facial cases, head injuries, etc.

When war broke out in September, 1939, the organization of the Emergency Medical Service was in part only on paper, and a very limited supply of the roentgen-ray apparatus that was considered necessary had been procured. In the light of the experience of the last war it was expected that the emergency hospitals would be called upon to deal only with real emergency work, *i.e.*, fractures and foreign bodies, and the apparatus that was selected as standard for the purpose was a mobile, ward trolley unit that would give 30 ma. at 90 kv. This was a compromise between efficiency and mobility, and, as is usual with compromises, it has not always met the needs, for reasons which will be given later. In certain areas, however, good full-scale roentgen-ray apparatus was to be transferred to emergency hospitals from the large city hospitals where, according to the scheme, the number of beds would be reduced to a fraction of the normal. Roentgen-ray apparatus particularly adapted to the requirements was to be installed in the hospitals set aside for special types of cases. The supply of radiologists was limited, and most of them, in addition to their normal work, had to take over a very large number of emergency beds, housed either in one exceptionally large and active hospital or in a group of smaller hospitals, often widely separated. There was a scarcity of skilled technicians to meet the increased demand, but at least one was allotted to each installation. They received special instruction in the methods of localization.

For many months after the outbreak of war many of the emergency hospitals were virtually empty, but in others work was provided by patients transferred from hospitals in the large cities, which had cleared most of their beds not only for the patients' safety but also for the provision of ample accommodation for air raid casualties. It was intended that these vulnerable hospitals should act as casualty clearing stations. The more difficult roentgenologic work in the emergency hospitals was carried out at well-equipped general hospitals in the locality. This was not a satisfactory arrangement, but the mobile unit installed

in most of the emergency hospitals, although providing adequate power for most purposes, was not suitable for anything but simple work, being supplied with a Potter-Bucky couch but no screening stand. It was not possible to provide large scale equipment everywhere, even if there had been a sufficient supply available. Hence, fixed sets were installed in certain of the larger new hospitals, and patients requiring gastrointestinal and similar examinations were transferred to those that had the necessary type of apparatus for work of this kind.

Just before the Low Countries were invaded the Army hospitals overseas were evacuated to the emergency hospitals at home. It had been intended that the convoys should go only to certain specified hospitals, from which the straightforward cases would then be transferred to other hospitals which were less well equipped. But in actual fact the convoys came over in such quick succession that this was not always possible, and as the large majority of cases were of the ordinary civilian type and not of the emergency nature expected, only a small proportion could be adequately dealt with with the mobile unit. Every effort had to be made to supply more and more fixed sets of apparatus to deal with this unexpected work, which had appeared in such quantity that it was clearly impossible to maintain the principle of transfer to suitably equipped hospitals. Even in the present days of intensive aerial bombardment the radiologist is still faced with a great deal of general medical and surgical work in both civilian and service cases.

With the downfall of Belgium and the evacuation from Dunkirk came the genuine emergency work that had been expected. But the calls upon the roentgenologic services were not those we had anticipated from our experience in the last war, for a complete revolution has taken place in the surgery of war wounds. Today it is no longer a case of free incision, drainage and three-hourly fomentations or irrigations, but of meticulously careful excision of the wound, with removal of all dead tissue and foreign matter, cloth, concrete, etc., that can be found. The metallic foreign body is a mere incident in the wound and one that is, by the nature of the material, much less likely to be a focus of septic trouble than are others which may not be visible on the roentgenograms. In a large proportion of cases the closed plaster method of Winnett Orr (that was found to be so successful in the Spanish war and which has been brought to the notice of the medical profession in this country by the admirable work of Dr. Trueta of Barcelona) is employed, with results that are, to anyone who watched the surgery of the last war, little short of miraculous, both in the healing of the wound and in the patient's comfort and freedom from pain. To the radiologist the use of this technique has meant an increased number of cases to be roentgenographed through plaster—and, it may be added, the odor of some of these cases when the plaster has been on for several weeks is something of a trial in a small roentgen-ray room!

The outlook of the surgeon today is first and foremost the excision of the wound and the removal of all dead tissues and foreign matter. He is much less concerned than formerly with the actual type of fracture and the position of the fragments of bone before operation, for he will, if necessary, open the wound freely and see these for himself. A roentgenogram will be helpful, but it is not so essential that the operation should be delayed for it, for early operation is of prime importance. In point of fact, however, even in the rush of work that followed the evacuation from Dunkirk, the roentgenologic service kept pace with the surgery, thanks to the way in which the radiologists and technicians got down to their task, often working without intermission all through the day and night until every patient had been dealt with. In some instances the radiologist set up his apparatus in the passage outside the operating theatres and kept pace with as many as

four operating tables, sending into the theatre the films and report with each case. It was all a matter of ordinary straightforward roentgenography; screening was seldom necessary. If foreign bodies were present, only anteroposterior and lateral views were necessary. These gave the surgeon useful information as to the probable track of the wound with which he had to deal. There was practically never a request for accurate localization. Even when foreign bodies are retained, accurate localization has as yet been seldom called for. This is in contrast to twenty years ago, when the retained foreign body frequently gave rise to symptoms and was generally found lying either in a pocket of pus or deeply embedded in a dense mass of fibrous tissue, from which it had to be removed by dissection, and for this purpose accurate localization was essential.

It will be seen, therefore, that the roentgen-ray service required immediately for emergency casualties is of the simplest kind. There is, however, a great demand for roentgen examination after operation, and it was in anticipation of this type of work that the standard equipment decided upon and supplied to emergency hospitals was of the mobile, ward-trolley type. But mobility is a relative term, and an apparatus that will give 30 ma. at 90 kv. is so heavy that it is mobile in only a limited sense, *i.e.*, along floors that are level and well paved. Many of the emergency hospitals are not on level sites and often consist of scattered units separated by such considerable distances that the transport of a mobile unit of this type is not practicable and patients have to be taken to the roentgen department or collected in those wards which can be served by the apparatus. In these conditions portable units of the 15 ma. at 85 kv. type are essential, and these are being supplied as quickly as possible. They are proving so efficient that in some hospitals only the most difficult cases and those in which screening is necessary are now dealt with in the roentgen department. This results in a great saving of transport of patients.

From experience in Spain it was expected that there would be large numbers of chest and abdominal wounds, in which the radiologist would be urgently called upon for the detection and localization of foreign bodies. The number of cases of this type as yet referred to the roentgen departments has, however, been surprisingly low.

The roentgenologic demonstration of gas in a wound does not necessarily imply invasion by the pathogenic gas gangrene organism. It is possible that the presence of gas in the depth of a wound may be due to the action of saprophytic bacteria or to the introduction of air at the time of the injury. If, however, the gas is observed to be spreading, separating muscle bundles and giving a streaky appearance on the roentgenogram, it should be regarded with grave suspicion, although the definite diagnosis must be made on clinical grounds. The use of roentgen rays for the treatment of gas gangrene has received little trial in this war, for this complication has not been of frequent occurrence. Whether this is due to the use of the sulfanilamide compounds or to the modern methods of wound excision is not clear, but the fact remains that up to the present there have been very few cases of the real gas gangrene that was so prevalent and so deadly in the last war.

This brief summary of the roentgenologic services of this war may be of some interest, and if it is felt that the civilian side of the organization has been unduly stressed it must be recognized that in this country today the civilian—man, woman and child—is as much in the front line of battle as is the man in uniform, and that the Emergency Medical Service provides for all war casualties.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. C. B. Peirce, Royal Victoria Hospital, Montreal, Canada. Annual Meeting: Cincinnati, Ohio, Sept. 23–26, 1941.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Next annual meeting: 1941, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Cleveland, Ohio, June 2-6, 1941.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting, 1941: To be announced.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets twice annually in May and September.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles Co. Med. Soc.
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. L. J. Taormina, 1093 Gates Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. H. A. Mahrer, 10515 Carnegie Ave. Meets at 6:30 P.M. at Mid-Day Club rooms on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. P. R. Weeks, 520 Republic Bldg., Denver, Colo. Meets third Friday of each month.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. J. N. Moore, 210 Professional Bldg., Ocala, Florida. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meetings held quarterly, on the fourth Sunday of the month.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, 23 E. Ohio St., Indianapolis, Ind. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. J. C. Bell, 402 Heyburn Bldg., Louisville. Meets annually in Louisville on third Sunday afternoon in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. J. E. Lofstrom, 1536 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. I. I. Cowan, Mt. Sinai Hospital, Milwaukee, Wis. Meets monthly on first Friday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. A. O. Hampton, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. W. J. Marquis, 198 Clinton Ave., Newark. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. E. J. Ryan, St. Luke's Hospital, New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport Pa. Meets annually.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave. Meetings held second Wednesday each month, 4:30 P.M., October to June at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. S. C. Davidson, 277 Alexander St. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. L. W. Baird, Scott and White Hospital, Temple, Texas. Next annual meeting, January 18, 1941, Sherman, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday of each month at the College Club, Seattle.

CUBA

SOCIEDAD CUBANA DE RADIOLOGICA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

FACULTY OF RADIOLOGISTS
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1, England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive for scientific discussion.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto, 5, Ontario.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134 ,Louvain (Belgium). Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel. Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aertze.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the spring, and one in the fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, M. Ponzio, University of Turin, Prof. Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly on first Monday at 8 o'clock.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St. Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen. Meets the second Wednesday of each month from October to July in Copenhagen, at 8'oclock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6:30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

BULLETIN OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY

THE RADIOLOGICAL CONSULTANT*

On the introduction of roentgen rays the problems were chiefly physical, and medical application resulted from collaboration between the physicist and the physician. As demands on the diagnostic and therapeutic use increased and broadened, it became necessary that some of those physicians particularly interested devote their time entirely to the medical application of roentgen rays and radioactive substances. This marked the first forward step in the establishment of a specialty.

Under the medical practice act any physician may make roentgenographic examinations and adminster therapeutic radiation. He may do this in connection with his other practice or limit himself entirely.

By definition a radiologist must necessarily have completed the prescribed course of study leading to the degree of Doctor of Medicine and have pursued special postgraduate study in radiology.

In the practice of radiology it is necessary to apply the same code of ethics and the same general practices as are recognized in other branches of medicine. These practices refer to both professional and economic subjects as any physician is judged both by his business methods as well as professional qualifications.

However, the specialist, be he gynecologist, surgeon or radiologist, in order to justify his existence as such, must perform the acts connected with that specialty more efficiently than any other physician. Without this particular ability there is no reason for his medical existence as a specialist.

The fact that many physicians consider the radiologist as a mere technician who "takes pictures" is unfortunate and yet true. The practitioner is frequently not at fault in this belief as his contact may be with the so-called radiologist who does just that. Those radiologists who are worthy of the name will give such good consultation as to convince their fellow physician that they are able consultants and can be of great assistance to both them and their patients. The "technician type," valueless as consultants, will fall by the wayside as will any other medical incompetent.

A major basis for the unfortunate relegation of the radiologist to the occupation of photographer is the situation in many hospitals where the radiologist is made a salaried employee. This causes the visiting staff to regard him as a servant procured by the hospital to carry out their orders, rather than a medical consultant available to them.

A second reason for this unfortunate classification of the radiologist arises from the practice of some which make their work subservient to adopted fee schedules. A set fee schedule can no more be practiced in radiology than in any other branch of medicine. The radiologist is not selling cellulose acetate by the square inch. Charges must be based on the amount of time and study required and related to the financial status of the patient. A minimum fee schedule is just as impractical as a maximum schedule. The sincere radiologist is honest and scientifically interested and will be fair in his estimate of fees. He, however, deplores any act of the referring physician which would seem to limit the scope or dictate the methods to be followed in his examination. A physician should refer a patient to a radiologist for consultation as regards a certain medical question and allow the radiologist to follow such procedures as in his opinion may be indicated.

Education of the laity is important. Education meaning that there should be sufficient information disseminated to constantly keep before patients as well as physicians the fact that radiologists make examinations and do not take "pictures"; that radiologists administer therapeutic irradiation and do not have "sittings."

* Presented by John D. Lawson, M.D., Chairman of the Section on Radiology, California Medical Association, Pasadena, May, 1938.

How frequently does the radiologist receive a phone inquiry: "Doctor, how much is an x-ray?" Expressed ignorance in this question is largely the fault of radiology and not of the inquiring person. So much effort has been given in scientific and technical advance that the necessity of keeping the profession and the lay population informed as to the status and practice of radiology has been neglected.

It is necessary always to explain in detail that the patient is not paying a fee for a certain amount of cellulose. They must understand that they have come to the radiologist for an examination, a consultation, and an opinion. Too much time and effort cannot be expended in explanation of these points to patients. Frequent presentation of this subject in medical conference is much in order lest it be lost sight of within the profession.

What should be the relation of the radiologist to the patient, and what should be the relation to the physician? These questions cannot be discussed separately as they are overlapping and consideration of one necessitates coordination with the other.

In the first place, the radiologist is primarily a consultant. The patient referred to him should be referred by the original physician for the purpose of diagnosis or treatment as the case may be. During the time that patient is being observed by the radiologist his actions should be those of any other consultant.

He should first obtain such history and physical examination as is necessary. Secondly, he should direct and supervise the taking of such roentgenograms as will assist him, and the referring physician, in arriving at a diagnosis. Thirdly, he should consider a request of the referring physician for specific types of roentgen-ray exposures or projections as a suggestion and not an order. Fourthly, he should not discuss with the patient his opinion or his findings any more than a medical consultant would give his opinion to a patient, on whom he was consulting with a surgeon. After the two opinions have been properly coordinated, and then only on the request of the referring physician, the radiologist may express himself to the patient. Finally, the radiologist should be certain that the patient is returned to his original physician having avoided any suggestion or criticism which would place doubt in the mind of the patient as to the procedures previously adopted.

In the case of patients referred for radiotherapeutic applications a somewhat different procedure must necessarily be followed. During the period of therapeusis, the patient must be considered as the patient of the radiologist. Reports at intervals to the referring physician are in good taste and should be given fully when requested. However, the patient is only in the care of the radiologist insofar as that immediate condition is concerned and any new or dissociated disability requires that the patient be returned to the original physician for its treatment.

One source of difficulty and misunderstanding lies in the type of consultation where a written report is rendered and there is no contact or discussion between the consultants. Many of these reports are merely a technician's description of a series of roentgenograms. Discussion of shadows, haziness, increased density and decreased density is had but no conclusion or diagnosis is included in the report. This is of little if any assistance to the referring physician. It is analogous to the internist who is asked to see a surgical patient in consultation and after a very careful detailed examination carefully enumerates the temperature, pulse, respiration, symptoms and signs in a long report to the referring physician. Certainly a discussion and conclusion must be given.

The question frequently arises as to the radiologist's position in examination and treatment of patients who are not referred by other physicians but come to him of their own volition. Can the radiologist, who must have in addition to his specialized

training, a good knowledge of diagnostic medicine say to the patient: "I am not capable of making this examination, you must see some other doctor?" Or should the radiologist make such examinations as seem advisable and after arriving at a diagnosis refer that patient to the physician he feels best suited to follow out the necessary therapeutic measures?

The radiologist is bound by the same code which pertains to any practitioner. Many consultants in all branches of medicine prefer to accept only referred cases. Thus he may feel free to refer the case for examination or may examine the patient himself as suits his preference. If he feels that it is in the interest of the patient to have other examination it is no admission of lack of ability for him to refer the patient elsewhere. The calling of one radiologist in consultation by another would add materially to the standing of these men and the specialty.

How about the examination of patients who have been under the care of practitioners of various cults? Are these afflicted to be told that a roentgen examination cannot be made or treatment cannot be administered because they have been seen by some practitioner not recognized?

The radiologist or any other medical man cannot ethically consult with unrecognized cult practitioners. The patient, however, is entirely within his rights in requesting an examination by some roentgenological procedure and it is quite proper that such an examination be made. The findings should be given to the patient together with proper advice as to whom he should consult. To refuse to examine the patient sends him back to the cultist and prevents his receiving such assistance as he needs. The request for the examination must come from the patient and he must be told that there will be no consultation with the cultist. The results of the examination must also be given to the patient or to some regular physician selected.

Frequently the radiologist receives a consultation request from a physician for a certain examination. If after a discussion with the patient as to symptoms and physical findings it appears that the examination requested is unwarranted and that either a different type of examination, or no examination at all, is advisable, this must be discussed with the referring physician who will thank the radiologist for his interest.

Much harm has been done by irrational and ill-advised radiotherapeutic measures; not so much to the patient as to the specialty. Especially is this true of useless and unnecessary publicity in the newspapers of certain procedures which are still in the experimental stage.

It is true that tonsils can be divested of their lymphoid tissue and in a large majority of the cases caused to become innocent structures. A patient requesting radiotherapy for chronic tonsillitis must be told that surgery is ordinarily the best method of procedure. Unless there is some reason why surgery should not be done, treatment should not be given. Similarly the treatment of chronic sinusitis within the last few years has received much publicity and all radiologists have been approached by the sinusitis victim with the request for therapy. If all these patients are treated, radiology will be justly criticized as many of these cases are not amenable to radiotherapy.

If radiologists are to obtain the support and respect of the medical practitioner he must do so by a demonstration of ability and fortitude. Mistakes in interpretation will be made and the well deserved caustic comments of the referring physician received. But behind it all will be recognized the sincere effort to assist, and it is quite possible that the referring physician, without too great an effort, will recollect some error he has made.

Each step which is taken in the daily routine of a radiologist is important not only to him but to the entire branch with which he is affiliated. Careless work, careless acts and careless words will only prevent him and his associates from their proper place in medical consultation.

CONFERENCE ON APPLIED NUCLEAR PHYSICS

During the week of October 28 to November 2, 1940, a Conference on Applied Nuclear Physics was held at the Massachusetts Institute of Technology, under cooperative sponsorship with the American Institute of Physics. The week's activities were divided into separate sessions on applications to biology, chemistry, radiology, metallurgy, geology, and general sessions relating to the production and use of radioactive and stable isotopes and the protection of workers from radiation. At this Conference more than one hundred scientific papers were presented and discussed. The Conference was divided into twenty-four half-day sessions. More than six hundred scientists, from all parts of the United States and Canada, and a few foreign workers, attended. This Conference admirably performed its purpose of bringing together investigators who are widely separated geographically, and of providing a forum for assembling and correlating present knowledge and difficulties, and for directing attention towards fundamental lines of research which should be the subject of future investigation. There are few fields of applied science which have ever in the space of only a few years proved so effective and so universally applicable as to produce the enormous amount of new and important work represented by the reports at this Conference. Those who are interested in detailed information should refer to the *Journal of Applied Physics*, in an early issue of which there will be published the abstracts of all papers presented at the Conference on Applied Nuclear Physics, as well as a number of papers summarizing individual fields.

AMERICAN COLLEGE OF PHYSICIANS

The Twenty-Fifth Annual Session of the American College of Physicians will be held in Boston, with general headquarters at the Statler Hotel, April 21–25, 1941. Dr. James D. Bruce of Ann Arbor, Mich., is President of the College and will have charge of the program of general scientific sessions. Dr. William B. Breed of Boston has been appointed General Chairman of the Session, and will be in charge of the program of clinics and demonstrations in the hospitals and medical schools and of the program of panel and round table discussions to be conducted at the headquarters.

CONFERENCE OF MID-WESTERN RADIOLOGISTS

The Fifth Annual Clinical Conference of Mid-Western Radiologists will be held in Rochester, Minnesota, February 14 and 15, 1941.

Vol. 45, No. 1

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave., Charleston, S. C.

TUBE TILT METHOD OF LOCALIZATION OF FOREIGN BODIES

By CAMPBELL HOWARD, A.B., A.M., M.D.

Professor of Radiology, New York Medical College; Head of Department of Radiology, Flower and Fifth Avenue Hospitals; Lieutenant Commander, M.C.V.(S.), U.S.N.R.

NEW YORK, NEW YORK

THE present national emergency with its plans for mobilization and training of troops revives many of the problems which faced the medical departments of the Army and the Navy in the World War. One of these problems was the development of mobile roentgen equipment. The present type of warfare practically demands that hospital units be as movable as the military unit which it serves. The base hospital can no longer be in a fixed position behind the lines since no longer are there definite lines of defense. Troops move here and there as the exigencies of life or warfare demand. Simplicity of the equipment of such mobile hospital units is essential. There should be no superfluous or complicated apparatus. This especially applies to roentgen equipment. Recently one of the large manufacturers designed and manufactured a complete roentgen unit mounted in an automobile truck. This, however, seems more expensive than is necessary to accomplish the desired result.

One of the important functions of the roentgenologist in a mobile hospital is to localize foreign bodies so that the surgeon can speedily and accurately remove them. During any active engagement every casualty must be surveyed by the roentgenologist. During the last war, every offensive, such as the St. Mihiel and Meuse-Argonne, resulted in a continuous stream of casualties being brought to the hospitals. These patients necessarily had to be handled with every possible speed. After passing through the "Triage" where they were registered and their clothing and possessions taken, they went immediately to the roentgen department for roentgenoscopic inspection and localization, and then they were transferred to the operating room for the necessary surgery.

I have a record of several hundred cases roentgenoscoped during a period of seventy-two hours continuous service. The speed with which this was accomplished could only have been done by means of a very simple rapid method of localization. This method meets all the requirements of field hospital use. From the time the wounded man is placed upon the stretcher he need not be moved until he reaches the operating room. The stretcher is lifted on to the roentgenoscopic unit and off without disturbing the patient.

The method of localization, which was used, is a simple adaptation of the triangulation method using a tube tilt instead of a tube shift. No doubt this method had been described elsewhere, but my review of the literature has not disclosed it.

This method depends on tilting the roentgenoscopic tube at a fixed angle instead of the lateral shift of the tube used in all other methods. The Standard U.S. Army roentgen table (which was designed and developed during the last war) was provided with parts necessary to carry out the method of localization proposed by Professor Strohl of the French Roentgenological Service. This method was very successful and permitted rapid localization. Wires had to be accurately attached above

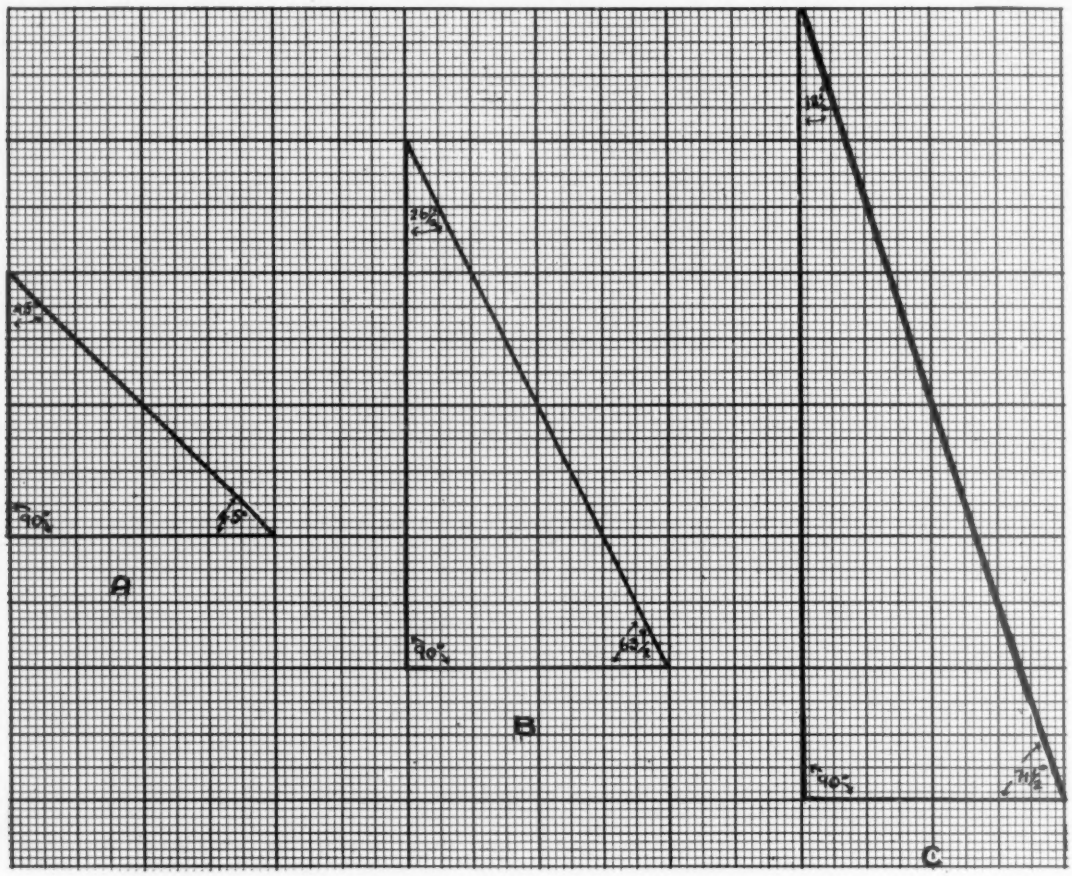

FIG. 1. *A*, base and altitude equal; *B*, altitude twice base; *C*, altitude three times base.

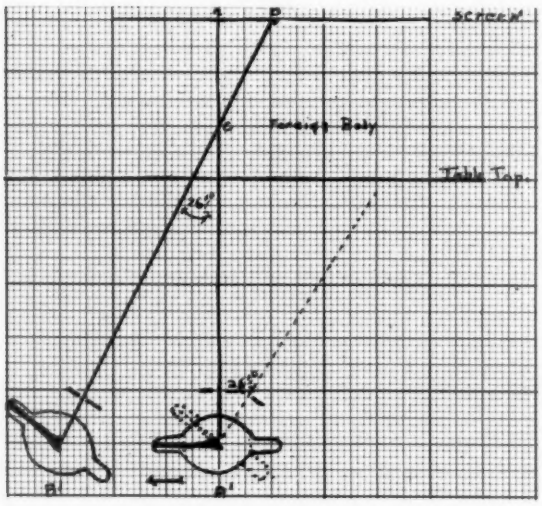

FIG. 2. Central ray projects image of foreign body at *A*. Tilt tube 26.5° directing central ray as shown by dotted line. Shift tube until central ray projects foreign body on screen at *B*. Distance *AB* multiplied by two equals depth of foreign body.

the tube in order to use this method. Claims for the present method are that it is even more simple and rapid than the Strohl method. The fixed tilt of the tube can be as readily designed and attached to any table as can the Strohl wires.

In a right angled triangle in which the opposite angles are equal, the base and the altitude are equal in length. If one of the angles is changed to 26.5° and the other 63.5° the altitude will then be twice as long as the base. If the angles are changed to 18.5° and 71.5° the altitude will be three times as long as the base. In similar triangles the relation of the base to the altitude is always the same (see Fig. 1).

The steps in the tilt method are as follows: Mark the fluoroscopic screen with a grease pencil at the point where the central ray passes through the foreign body. Then tilt the tube 26.5° and move it until the

central ray again passes through the foreign body. This second point is marked on the screen. The distance of the image shift multiplied by two represents the depth of the foreign body below the screen. Deduct 0.5 cm. for thickness of the screen. The diagram below shows how this result is obtained (see Fig. 2).

The simplicity of this method makes it practical under all conditions. The only requirement is that the tilt of the tube be available in the fluoroscope. Such an adaptation could readily be made by supporting the tube on a cylinder with a sleeve permitting the tilt desired. During the St. Mihiel and Meuse-Argonne drives, using a table permitting this tube tilt, this method proved to be most successful and accurate.

MOBILE ROENTGEN-RAY UNIT USED AT THE NEW YORK WORLD'S FAIR

By J. P. HOGUET, M.D., AND ROBERT MAZET, JR., M.D.
NEW YORK, NEW YORK

IT BECAME evident early in the organization of the Medical Department of the New York World's Fair that diagnostic roentgen-ray equipment would be not only desirable, but necessary. Since the Fair grounds comprise an area of over twelve hundred acres the establishment of six first aid stations located at strategic points was obviously a much more practicable arrangement than having a single large unit, and the ready accessibility of many hospitals obviated the necessity of providing anything more than emergency treatment. The Medical Department has five ambulances for the transportation of non-ambulant patients to the dressing stations, and to hospitals if necessary.

The department commenced to function in August, 1937, soon after construction on the site started, with a single medical unit. As the number of workmen engaged in construction increased two field stations were opened, and these continued to function until the opening of the Fair.

The expense necessary to install diagnostic roentgen-ray apparatus in each of the stations being prohibitive, the senior author and Dr. C. I. Headland, Consulting Roentgenologist, evolved plans for the mobile unit described here.

The unit consists of a special body on a standard one and one-half ton Mack truck chassis, in which the driver's seat is placed over the motor. The inside diameters of this body are 6′8¼″ × 10′8″ and headroom of 6½ feet is provided. The body is completely insulated, but ventilation is provided by three light excluding louvres, one in each side, and one in the top. Its door is in the rear, with a step, and also a slide to permit rolling the portable unit in and out. It is, then, actually a moving dark room.

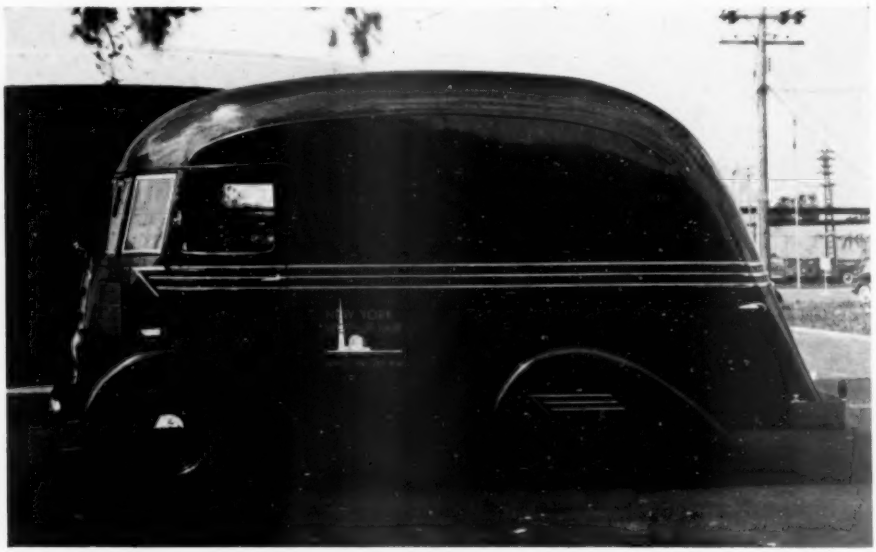

FIG. 1. Side view of unit.

The equipment contained within the truck consists of:

1. A portable Diadex Westinghouse Roentgen-Ray unit with roentgenoscopic attachment. A specially constructed cushioned rack carries the tube.

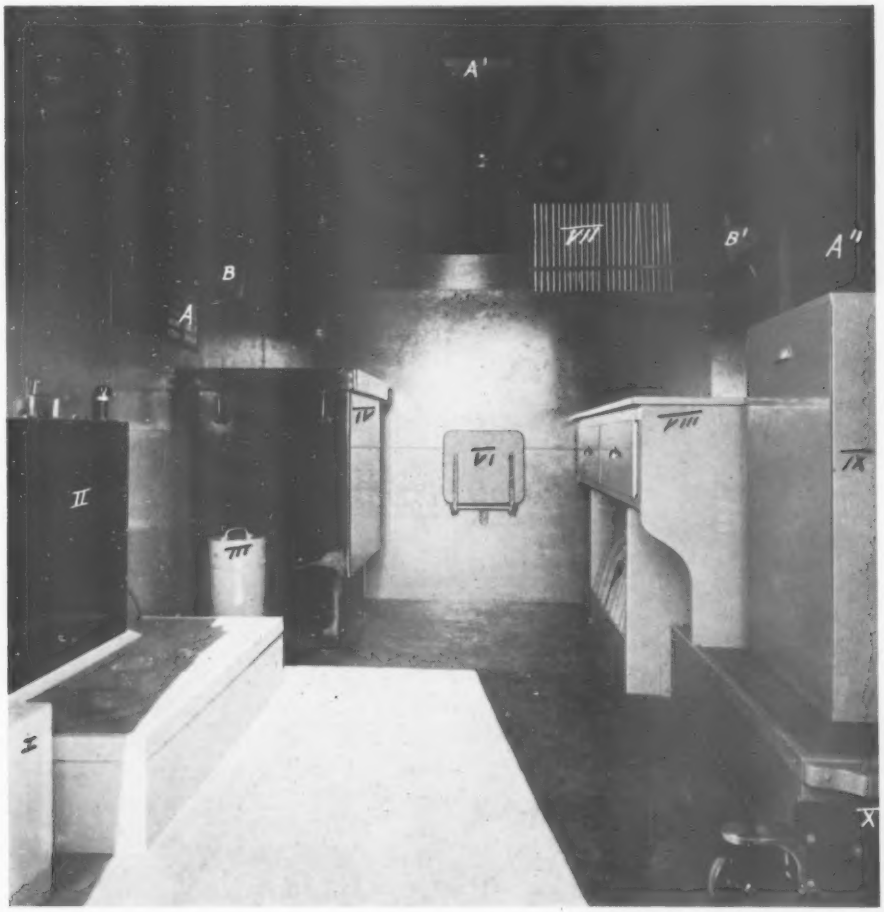

Fig. 2. Interior view of unit looking forward. *I*, cushioned rack for tube (16″×13″); *II*, Potter-Bucky diaphragm; *III*, container for dry ice; *IV*, developing tank; *VI*, drop seat (12″×12″); *VII*, rack for film holders; *VIII*, work bench with cassettes underneath (56″×24″); *IX*, film safe (18½″×21″); *X*, portable unit; *A*, *A'*, *A"*, ventilators; *B*, *B'*, dark room lights.

2. A standard three compartment 5 gallon developing tank, cork insulated, with a cover which clamps down tightly to prevent spilling and mixing of contents when the truck is under way. A hose connection to an ordinary faucet, and a drain provide for water changes.

3. An electric heater for warming the developing fluid.

4. A container for carbon dioxide snow to cool the developing fluid.

5. Racks for film holders, a safe for films, and holders for cassettes and the Potter-Bucky diaphragm.

6. Two dark room lights, and two ceiling lights operated on the truck's storage battery.

7. A workbench 24″×56″ for loading cassettes, etc.

8. A recharger for the storage battery with a 50 foot extension cord which operates on current from a wall plug.

9. A drop seat.

When a doctor in one of the dressing stations wishes to make a roentgen examination the truck is called by telephone from its base station, and proceeds at once to the desired location. The portable unit is then rolled to the patient, and plugged into the nearest wall outlet. The patient is not moved. The roentgenogram having been taken, it is developed in the truck immediately.

The mobile unit described above has

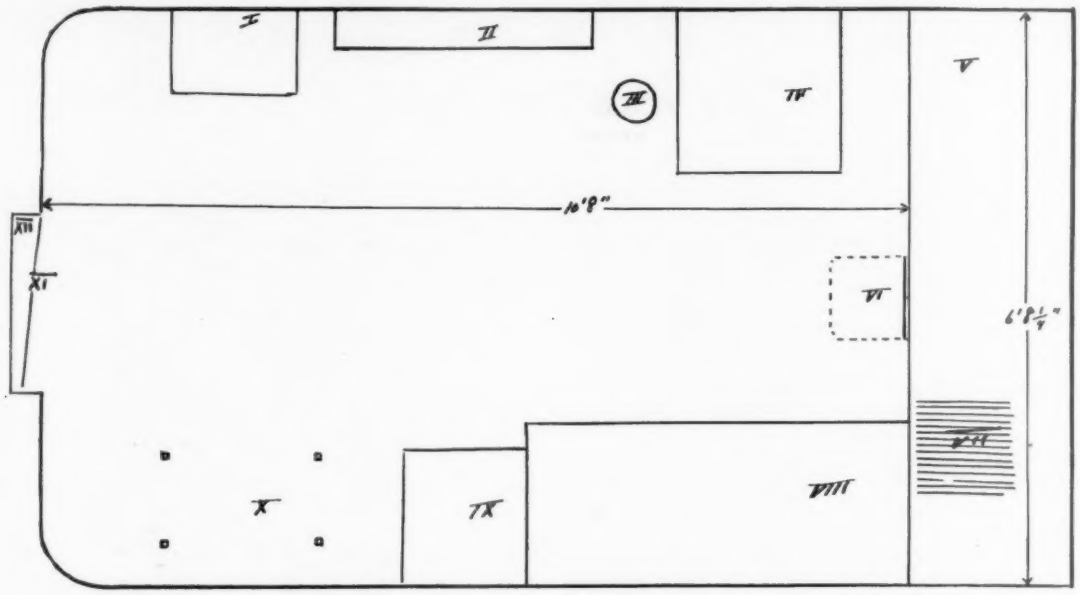

FIG. 3. Diagram of floor plan of interior of unit. *I*, *II*, *III*, *IV*, *VI*, *VII*, *VIII*, *IX*, *X* are the same as in Figure 2. *V*, shelf over driver's seat (6′8″×2′8″); *XI*, door, 2′8″ wide; *XII*, step.

proved itself of inestimable value in the determination of the extent of injury in workmen injured during the construction period of the Fair, and has in several instances been the deciding factor in whether or not to hospitalize the patient.

Vol. 45, No 1

THE ANTEROPOSTERIOR VIEW OF THE ANKLE JOINT AND FOOT

By PHILIP J. SANTORA, M.D.
NEWARK, NEW JERSEY

MY ATTENTION was called to the fact by physicians in both private practice and at the Newark City Hospital, Newark, New Jersey, that many roentgenograms of the ankle joint and foot diagnosed as "negative for fracture" or just called "sprains or trauma," in many cases upon closer examination, revealed fractures.

Since my practice consists of a considerable amount of accident and industrial compensation work where the patients must be roentgenographed for foot and ankle fractures which eventually become legal in character, I endeavored to find a method of examination that would aid in revealing the osseous structures of the ankle joint, foot and lower portions of the tibia and fibula clearly, thus making it much easier to make a diagnosis and to visualize the parts involved more clearly.

FIG. 1. Showing position of the tube, foot and angle block.

A *B*

FIG. 2. *A*, usual method used. *B*, technique described herein.

Using the various methods employed and finding none to be satisfactory, I developed the following procedure:

With the patient in a sitting position on the table, and the foot resting with the plantar surface on the film holder on a block cut at an angle of 23 degrees, with the heel at the lower end and the toes at the uppermost end, the tube is tilted at 10 degrees towards the ankle joint, as illustrated in

Figure 1. The central ray passes through the tallus tibial joint, using the medium sized cone if just the ankle joint is wanted or the larger cone if the whole foot is to be included.

A block is used large enough to accommodate an 11″×14″ film, as it permits three views of the ankle joint, the foot and lower end of the tibia and fibula on one film. The anteroposterior view is taken as already described, the anteroposterior view of the lower third of the leg and the lateral view of all the structures. However, both views, the anteroposterior and lateral, may be taken on an 8″×10″ film.

The angle block is made up of pine or balsam wood. Balsam wood is used if the roentgenograms are to be made when using the Potter-Bucky diaphragm, the base of the block being 11×14×½ inches. I have placed aluminum edges to keep the holder in place and to avoid movement. The block is cut at a 23 degree angle.

The technique used on the film holder is as follows: anteroposterior view, time five seconds, 30 ma., 80 kv. (peak), distance 30 inches. The lateral view is taken in the usual manner.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

HARE, CLARENCE C., and SCHWARZ, GABRIEL A. Intracerebral carcinomatous metastases. *Arch. Int. Med.*, Sept., 1939, *64*, 542–565.

Carcinoma may extend to the central nervous system by at least three routes: direct extension along nerve sheaths; bony invasion and via meninges, and retrograde by way of lymphatics or as emboli via the blood stream.

The authors are reporting on 100 cases of intracerebral carcinomatous metastases (27 of which were less than forty years of age) studied at the Neurological Institute and the Presbyterian Hospital, in New York (34 studied by autopsy). Great variation in statistics dealing with metatastic lesions in the brain is found in the literature because of the fact that most compilations of this sort have emanated from clinics dealing particularly with this type of case, thereby having restricted clienteles. The incidence of cerebral metastases from bronchogenic carcinoma, for example, has been cited as low as 9.7 per cent and as high as 39.2 per cent. Of the authors' 100 cases, the primary was in a bronchus in 42; breast, 23; stomach, and intestine, each 3; kidneys, adrenals and thyroid, each 2; colon, rectum, ovaries, uterus, penis, scalp and finger, each 1 and undetermined, 16 (thus, 65 per cent or more were of bronchus or breast origin). The duration of neurological symptoms varied from a few days to more than a year. Cerebral symptoms due to primary tumor of the brain were found to be of longer duration prior to hspitalization than were those due to metastasis (except for glioblastoma multiforme). The average duration of life from the time of the first symptoms was about 6.4 months. The first symptoms included: convulsive seizures, 10 cases; headache, vertigo and / or vomiting, 15; hemiplegia or hemiparesis, 3; aphasia, 2. Visual symptoms included blurring of vision, diplopia, photophobia and amblyopia (17 showed papilledema). Seven of the cases showed evidence of meningeal irritation (by way of slight nuchal rigidity). Cerebral spinal fluid was studied in 54 cases and of these 70.3 per cent showed abnormalities (increase of total protein and globulin, increase in cellular content, positive Wassermann reactions). Stereoscopic roentgenograms were studied in 91. Of these, 51 showed abnormalities: 15 lesions in the skull; 24, displacement of the pineal; 22, erosion of the clinoid processes (10 of which had noted symptoms less than three months); 1, calcification of the tumor mass itself (primary, in the breast, five years previously; symptoms less than two months). Encephalograms were obtained in 10 cases: 8 of these showed abnormalities indicative of tumor. Ventriculograms were obtained in 9 additional cases, 6 of which showed abnormalities. Roentgenograms of the chest were obtained in 35 of the 42 cases of primary carcinoma of the bronchus; in 27 of these, the primary tumor was identified; in 7, the findings were considered to be due to an infectious process; 1 showed pleural effusion. In 22 of the 23 cases of primary in the breast, the interval between the mastectomy and the first neurological symptom averaged twenty-five months.

Pathologically, multiple tumors were found in 20 cases; single, in 14. The cerebrum was involved in 26; the cerebellum in 16; the brain stem in 6, and the pituitary gland in 2. Most of the larger tumors seemed to extend into the white rather than the gray matter. The larger tumors showed a considerable degree of central necroses. In a few instances, tumor cells were found in the lumina of vessels. Practically all the cases showed metastases in other organs.

Treatment should be confined to providing comfort. In general, the authors emphasize that roentgenography of the chest should be practiced routinely before proceeding with craniotomy.—*A. A. de Lorimier.*

MENG, C. M. Tuberculosis of the mandible. *J. Bone & Joint Surg.*, Jan., 1940, *22*, 17–27.

Meng reports 14 cases of tuberculosis of the mandible. Of these, 8 were seen within a period of two and one-half years. The majority of patients were in the second and third decades of life. Swelling, discharging sinuses, and occasionally trismus of the jaw were the chief complaints. About 43 per cent of the patients had tuberculous lesions in other bones of the body, and tuberculosis of the skull was coexistent in 29 per cent. In 10 of the cases in which the chest

was studied roentgenographically, evidence of tuberculosis either in the lungs (8 cases) or in the pleura (2 cases) was seen. Pathogenically, it appears that the tuberculous infection of the mandible is almost always hematogenous, originating from a primary focus elsewhere in the body, most likely in the lungs, although the mandible may be involved from extension of a tuberculous lesion of the mucous membrane of the oral cavity or from infected gingivae about carious teeth.

Roentgenographically, either slight change or very extensive involvement of the mandible may be seen. Rarefaction and necrosis of the bone are evident. Involucrum is scanty and often absent. Sequestration, however, is frequently observed. Small sequestra, although often not detectable in the roentgenograms, may be found in a bone cavity at operation. The entire length of the ramus may be sequestrated or even displaced far from its original site. Pathological fractures are common. The lesion may involve the angle of the mandible or the alveolar process of the body. Occasionally a cyst-like cavity may be noticed in the body of the mandible below the roots of the bicuspids and the first molar tooth. The outline of the cavity may be indistinct. In the cavity, faint bone shadows may be indicative of thin, small sequestra. The cortex of the bone may be very slightly expanded over the cavity, but this expansion hardly reaches significant dimensions before spontaneous rupture takes place and a sinus is formed. It is apparent that the roentgenographic diagnosis of tuberculosis of the mandible is difficult.

Rational therapy must emphasize general antituberculous measures in addition to local treatment of the tuberculous lesion of the mandible.—*R. S. Bromer.*

PIERGROSSI, ALDO. Sugli aspetti radiologici dei granulomi apicali del dente e delle cisti radicolari. (Roentgen appearances of granulomata of the apices of the teeth and of root cysts.) *Arch. di radiol.*, July–Oct., 1939, *15*, 461–490.

For a long time odontologists have known of the small tumors, sometimes solid, sometimes cystic, that adhere to the apices or roots of teeth extracted for chronic inflammation, but it was impossible to study these structures closely until after the introduction of roentgen rays. Essentially these apical granulomata or root granulomata are proliferations of granulation tissue which develop in or around the root apex from chronic periodontal inflammation. They are ordinarily caused by streptococci or staphylococci or the ordinary oral bacteria. They may result from an acute or subacute periodontitis that has become attenuated or from an inflammation that has been chronic from the beginning. It is generally an acute exacerbation of the inflammation that brings the patient to the physician.

These granulomata are classified into simple, epithelioforous, or epithelial-bearing and cystic. The author prefers the term epithelioforous to epithelial for the latter word suggests that the granulomata are made up entirely of epithelial tissue. Simple and epithelioforous granulomata cannot be differentiated roentgenologically. They are both manifested by a periapical area of rarefaction of bone with irregular and not very distinct outlines. Granulomatous cysts, on the other hand, have very clear, regular and distinct outlines. They originate from disintegration of the simple granulomata and are much more frequent than the latter. About four-fifths of the author's material consisted of granulomatous cysts. Many details of the roentgen images seen in the different teeth are described and the differential diagnosis from normal and other pathological conditions discussed. With care in the technique of taking the roentgenograms these granulomata can generally be differentiated from the normal structures with which they are frequently confused.

When a granulomatous cyst becomes larger than a large pea or a small hazelnut it is called a root cyst. Generally these cysts are indolent and are first manifested by a slowly increasing swelling extending either externally or into the mouth. The roentgen appearance as compared to that of cystic granuloma differs according to the size of the cyst and its relation to neighboring organs. Roentgenograms of these forms of granulomata and cysts are given.—*Audrey G. Morgan.*

NECK AND CHEST

PEIRCE, CARLETON B., and STOCKING, BRUCE W. The roentgenological anatomy of the chest. II. The bronchial distribution. *Am. Rev. Tuberc.*, April, 1939, *39*, 516–527.

The authors stress the importance of knowing bronchial anatomy, particularly for the sake of interchange of opinions by the bronchos-

copist, the internist, the surgeon, the clinician and the roentgenologist.

Variations in the anatomy are rare, the most common variant being in the right upper lobe due to the azygos vein. Occasionally a pleural fissure in either side at the base may produce an apparent accessory lobe. The lingular portion of the left upper lobe may be fissured, thereby presenting the appearance of a left middle lobe.

In the past, descriptive terminology relative to the bronchial tree has been largely with reference to cardiovascular structures, using terms such as "eparterial," "hyparterial," etc. In lieu of such, the following nomenclature is recommended:

I. Right bronchus
  A. Superior bronchus
  B. Intermediate bronchus
    1. middle lobe bronchus
    2. dorsal bronchus
    3. inferior bronchus
      (a) dorsal-basilar bronchus
      (b) median-basilar bronchus
      (c) ventral-basilar bronchus

II. Left bronchus
  A. Superior bronchus
    1. superior trunk
    2. lingular bronchus
  B. Inferior bronchus
    1. dorsal bronchus
    2. dorsal-basilar bronchus
    3. median-basilar bronchus
    4. ventral-basilar bronchus

The right oblique projection affords maximum visualization of the right posterior lung fields, and for bronchography, it displays the left bronchial tree to a maximum. The left anterior oblique projection affords maximum visibility of the left lung field and the right bronchial tree. The importance of these oblique views is emphasized to the extent of recommending stereoscopic projections of such rather than of routine posteroanterior and laterals. Very clear line drawings are included.—*A. A. de Lorimier.*

Lindberg, D. O. N. An x-ray study of the adult relief population of a small community. *Am. Rev. Tuberc.*, May, 1939, *39*, 666–670.

Previous studies by the author have indicated an incidence of pulmonary tuberculosis among 1,005 adult negroes to be only slightly above that found among 705 white school teachers; yet the mortality rate among the former group was actually 3.2 times that among the whites.

The present study concerns 1,054 relief workers, adults between twenty and fifty years who were on relief for four years or longer. Active parenchymal lesions were found in 1.0 per cent (minimal, 0.5 per cent; moderately advanced, 0.3 per cent, and far advanced, 0.2 per cent). Definite parenchymal lesions of secondary, inactive types were observed in 2.9 per cent.

Comparing these statistics with the findings in previous studies, the author emphasizes the increased incidence of inactive lesions among the two groups with the lowest standards of living. He suggests that interval rests may allow these individuals to handle their infections. Unemployed victims learn of their infections when it is too late for adequate healings.—*A. A. de Lorimier.*

Cummings, D. E., Downs, R. N., and Berg, Melvin. Tuberculous lesions in male industrial workers; their incidence and significance as disclosed by stereoscopic chest roentgenograms. *Am. Rev. Tuberc.*, April, 1939, *39*, 439–455.

Mass chest studies have been accomplished by means of stereoroentgenograms on two groups of workers: 5,000 steel workers (statistically reported to average fifty-third in a list of 72 occupations arranged in the order of deaths from tuberculosis) and 5,000 engaged in various activities of mining (underground miners statistically heading this list of occupations). The studies were carried out over a five year period.

Referring to the merits of roentgenological examinations, reports by others have indicated an incidence of tuberculous lesions as high as 4.76 per cent among average workers presenting no discernible evidence of reaction to occupational exposures. Among the 5,000 steel workers, the incidence was 5.24 per cent—a favorable comparison with the "normal." However, there was a conspicuous variation in the incidence of tuberculin lesions with consideration of age; for less than twenty years, only about 1 per cent showed lesions, while from sixty-five to seventy-four years, the incidence rose to 12.5 per cent. This increase in the older age brackets is attributed to the development of new infections. The death rate was found to be fairly constant for the various age groups, the ratio being one death for ap-

proximately 80 cases of recognizable lesions. Among the steel workers the incidence of tuberculous lesions for the Negro and Mexican groups was found to be about the same as among the whites but the death rates were greater among the former groups—likely due to a lack of inherent immunity in those individuals.

The findings among the 5,000 miners were classified according to degree of reaction to dust exposures: (1) normal, (2) peritruncal exaggeration—first evidence of nonspecific reaction to dust, (3) second degree peritruncal exaggeration, (4) third degree peritruncal exaggeration, (5) first degree nodulation (first evidence of specific reaction to silicosis), (6) second degree nodulation and (7) third degree nodulation. The incidence of tuberculous lesions was found to increase as the degree of reaction to dust increased. Tuberculous lesions were found in approximately one-fourth of the group with first stage silicosis; in one-half of those of stage 2 "silicosis" and 65 per cent of those of stage 3. The relationship of dust was found to be much greater than that of age: for instance, the incidence of tuberculous involvement among younger individuals (25 to 35) having also silicosis, was found to be more than seven times that of other groups while among older miners (65 to 74) this incidence was merely double that of others not in contact with dusts. —*A. A. de Lorimier.*

SAWYER, W. A. Tuberculosis control in industry. *Am. Rev. Tuberc.*, April, 1939, *39*, 456–478.

This analysis deals with physical examinations including single film studies on 3,280 apparently well adults, applicants as employees of the Eastman Kodak Company. Two and four-tenths per cent were diagnosed "positive" while 1.4 per cent were diagnosed as "suspicious," these being subsequently studied by stereoroentgenograms. Since all of them were unsuspected cases having no clinical symptoms and no diagnostic physical signs and since they became proved by their subsequent clinical courses, there was developed serious question as to the trust which should be given the stethoscope.

Beginning in 1928 it became the practice to make annual stereoroentgenograms of the chests of all employees and applicants. Later, those over thirty were exempted from the annual studies but, for them, studies were made at intervals of two or three years. The particular value of stereoroentgenography is emphasized because of distinguishing fibrotic or calcified lymph nodes from vessels on end; distinguishing true infiltration from vascular movements; providing identification of artifacts, and providing for separation of soft tissue densities from superimposed bone densities (both by third dimensional vision and by comparison of relative positions on the two films). Fluoroscopic substitution was not considered a practical substitute because of the lack of diagnostic trust except in the hands of the most expert; the confinement and fatigue of the physician and the possibilities of exposure danger to the patient and the doctor.

Roentgenologically, the classification of the American Tuberculosis Association was followed. After following certain cases for years, it appeared that peritruncal infiltrations were normal physiological roentgenographic manifestations, rather than evidences of pathological infiltrations of a tuberculous nature. On the other hand, many lesions which had been considered "inactive" or "negative" or "primary complex" later showed definite clinical activity, but a number of these showed complete involution with as little as six to twelve weeks bed rest. Tuberculin tests offered very little aid except to indicate that there had been infection. "Primary" and "inactive" cases were accepted for employment.

Some cases showing "areas of infiltration soft in appearance" were also taken but such cases were studied more frequently and they were advised to rest as soon as there was any evidence of increase in size of the lesions. Of the 4,665 employees studied, 6.6 per cent of those diagnosed as negative gave a history of known family exposure and only 9.3 per cent of those showing infection gave such a history,—"little difference in exposure between the negatives and positives." No particular nationality showed susceptibility. Though many cases occurred among individuals of greater than average weight, there was a definitely increased rate among those of less than average weight. Only 15 cases (0.3 per cent of the 4,665 individuals) developed new activity subsequent to the first examination and between 1928 and 1935 (average age, thirty-three years).

Some 4,640 applicants were studied since 1935. Again, males numbered 2 to 1 female;

32.1 per cent showed primary infections; 0.5 per cent were diagnosed as "active or clinically significant." Between 1900 and 1937 the mortality rate from tuberculosis in Rochester, New York, was reduced from 175 to 24 per 100,000 population. Special rest was found to be most important and the progress paralleled early recognition of the disease.—*A. A. de Lorimier.*

Rubin, Eli H. Haematogenous tuberculosis in the adult. 1. Generalized haematogenous tuberculosis. *Am. Rev. Tuberc.*, May, 1939, *39*, 557–586.

Tubercle bacilli may invade the blood stream at any stage of tuberculosis and at any age. The stage of the disease seems to influence the incidence of implantations in various organs of the body, the age of the patient playing a minor rôle. Wilson has estimated that tubercle bacilli have been demonstrated in the blood in about 4.9 per cent of patients having severe pulmonary tuberculosis: 2.7 per cent having nonpulmonary tuberculosis and 36.4 per cent with miliary and meningeal tuberculosis. The organisms may gain entrance into the blood by: (1) an efferent lymphatic from a caseous lymph node, to the thoracic duct and thence into the venous circulation; (2) invading a blood vessel after settling in the subintima, and (3) by rupture of a caseous focus directly into the lumen of a blood vessel. Localized forms of hematogenous infection result from the organisms gaining access to smaller radicles of the venous, arterial or lymphatic channels.

Various morphological forms of hematogenous tuberculosis may occur: classical miliary tuberculous necrotic foci simulating small abscesses, large tuberculomata, simulating neoplasms and even bronchopneumonic infiltrations. Fourteen cases are described to exemplify these types, demonstrating septic, typhoid, meningeal, dominant pulmonary localization, dominant throat localization, dominant intestinal localization and healed generalized miliary tuberculosis all as examples of disseminations by way of the blood stream. Exemplifying chronic miliary types, cases are cited which represent a protracted course with death due to other causes; cases showing predilection for serous membranes (corticopleural and polyserositis) and bizarre types such as noncaseating lesions and recurring round infiltrates. Circumscribed pulmonary lesions in the course of generalized hematogenous tuberculosis are likewise considered—hematogenous tuberculosis may give rise to a localized as well as a generalized disease.—*A. A. de Lorimier.*

Zacks, David. Pulmonary tuberculosis in the second decade of life. 1. Its development and fatality. *Am. Rev. Tuberc.*, June, 1939, *39*, 683–702.

Reinfections or disseminations of pulmonary tuberculosis as found during the second decade of life are characterized by a very insidious onset and development, usually with no weight loss (with proper rest there might even be continuous slight gain) with no toxic symptoms and with no noticeable fever (under sanatorium observation, only slight or moderate fever might be noted, even during cavity formations). Regardless, roentgen studies will show a steady extension of a lesion in the majority of cases, at this age. An extensive hematogenous spread may occur without any symptoms; bronchogenic spread is more likely to be accompanied by fever, symptoms and signs and most cases do reach a stage of symptomatology though this may not occur until shortly before death.

The author has studied 536 white children over an average period of four years. The ratio of girls to boys figured approximately 2 to 1; 63.6 per cent had familial contact; 35.5 per cent had symptoms and/or signs referable to the chest while 12.9 per cent had positive sputum; 13.9 per cent had cavities. Four hundred and forty-three of the group belonged to a school clinic (presumably well). Among them, the diagnosis was made exclusively by roentgen studies in 72.5 per cent (in only 27.5 per cent were the findings supported by symptoms and/or signs—sufficient to classify as manifest disease). The sputum was positive in 6.8 per cent of these. Ninety-three of the total group studied had been reported by county clinics or private physicians. Of these, 73.1 per cent had symptoms and/or signs in addition to roentgen findings and the sputum was positive in 41.9 per cent.

The location and extent of the original lesions were not known in 5 of the children. However, of the other 531 cases, 87.2 per cent were apical (unilateral or bilateral); 12.8 per cent, either sub- or infraclavicular, 5.5 per cent showed cavities. Unilateral basal shadows were usually, and bilateral shadows almost always nontuberculous. Roentgenographic studies were made at intervals of ten days to two weeks in the beginning and cases were classified as

"progressive" and "retrogressive"—rather than "exudative," "productive," "caseous-pneumonia," etc. Soft lesions usually progressed in severity but some healed completely while some well fibrosed and even partially calcified lesions went on to a fatal termination. Strand-like or stringy shadows, either apical or subclavicular, tend to remain stationary for a long time with rare exceptions and, after puberty has passed, many remain stable. The younger the child the slower the rate of spread. (Seven years average for the group five to nine; five years, for ten to fourteen and only three years for fifteen years or more.) At the end of four mean years of observation, two-thirds of the cases were found to have progressed (as far as roentgen evidence) and 44.5 per cent of the asymptomatic lesions developed symptoms and/or signs; 19.3 per cent developed cavities. Of those who previously had no sputum or whose sputum was negative for the tubercle bacillus, 23.1 per cent had developed positive sputum (in an average of 3.5 years after diagnosis). The ultimate outcome was found to be uncertain for at least ten years, especially for the cases with minimal lesions. The mortality rate was increased in the presence of cavity as compared with the "open case" (for the first year, mortality rate for the open cases: 7.4 per cent for boys; 12.5 per cent for girls, while with cavities these percentages increased to 8.4 per cent and 14.0 per cent, respectively). There was no significant difference between contact and non-contact cases. With calcified tracheobronchial nodes, the mortality percentages were less. The duration of life was inversely proportional to the extent of the lesions and likewise, to the age at the time of diagnosis. Though the incidence was twice as high for girls, the case fatality rate was essentially the same for both sexes.—*A. A. de Lorimier.*

ZACKS, DAVID. Pulmonary tuberculosis in the second decade of life. II. Its treatment and prognosis. *Am. Rev. Tuberc.*, June, 1939, *39*, 703–713.

This report deals with an evaluation of treatment methods as observed in care (average of four years) of 536 children with pulmonary tuberculous lesions. It is realized that accurate appraisals can be made only after an observation period of ten years.

Ordinary rest has been enforced by the State of Massachusetts for all children showing pulmonary infiltration. Bedrest alone for shorter or longer periods has failed utterly to influence the course of the disease, both as far as minimal and advanced positive sputum cases were concerned. Those given treatment early (within one year of diagnosis) showed only a slightly but not significantly lower mortality rate. Pneumothorax has not benefited the advanced cases to any appreciable extent—though it did tend to prolong life. Collapse therapy did benefit cases with cavity; the value of this regimen of treatment as applied early cannot be estimated for another five years. For the selected cases, thoracoplasty showed a slightly greater benefit as compared with pneumothorax.

The author suggests the following: "In the age group five to nine years, chronic subclavicular infiltrations should be treated by bed-rest alone. In older age groups, attack immediately cavity cases and apical lesions beyond the second anterior ribs. For subclavicular processes, allow a month or two in bed for observation by frequent serial films to determine whether the lesions show definite retrogressive changes. If definite retrogressive changes do not occur, if the lesions remain stationary or show a tendency to spread no matter how slight, attack at once. An exception to this rule is perihilar or peritracheal infiltrates when observed during their spreading phase which should not be collapsed immediately as these lesions will probably undergo spontaneous retrogressive changes. Apical lesions not greater in extent downward than the second anterior ribs should be given a period of three to six months' observation in a sanatorium by serial films. If the lesions do not show a tendency to retrogress at the end of the period, then attack by pneumothorax. If adhesions hamper a good collapse, these should be surgically severed without waiting too long and the pneumonolysis should be done as thoroughly as possible to give the desired result. Pneumothorax should not be carried on too long for extensively adherent apical lesions that cannot be severed by pneumonolysis, as thoracoplasty is a much better procedure for these cases and will often avoid purulent exudates."

Roentgen studies indicated that for the subclavicular or infraclavicular lesions in the first decade of life, the prognosis was good—they behave like primary infiltrates. Likewise, soft apical infiltrates showed a good incidence of healing. Extensive lesions beyond the second

anterior ribs, cavity cases and sputum positive cases found in individuals of the second decade of life have a poor prognosis. Advanced lesions when accompanied by toxic symptoms carry a hopeless prognosis. More important than the extent of the lesion is the behavior noted by serial roentgen studies.—*A. A. de Lorimier.*

McIndoe, R. B., Steele, J. D., Samson, P. C., Anderson, R. S., and Leslie, G. L. Routine bronchoscopy in patients with active pulmonary tuberculosis. *Am. Rev. Tuberc.*, May, 1939, *39*, 617–628.

Bronchoscopic examinations were performed as a routine on 272 patients admitted to the Michigan State Sanatorium.

Evaluation of bronchoscopy was based upon:

1. Indications of tracheobronchitis as obtained by a carefully taken history.
2. Roentgenography before and after bronchoscopy.
3. Interval laryngeal examinations.
4. Sputum studies before and after bronchoscopy.
5. Comparison of temperatures before and after bronchoscopy.

The bronchoscopic findings revealed 11 per cent to have definite evidence of tuberculous lesions in the trachea or bronchi. These included five types:

1. Submucosal (diffuse or circumscribed thickenings with unbroken mucosa).
2. Tuberculoma (an isolated projecting tumor).
3. Ulcerative (localized or diffuse).
4. Fibrostenotic (with cicatricial narrowing of the lumen).
5. Ulcerostenotic (lesions combining 3 and 4).

Eleven per cent showed mucosal congestion; 7.9 per cent merely "distortion, kinking, or scarring"; 4.9 per cent "questionable involvement," and 1 case (0.4 per cent), was found to have a bronchogenic carcinoma (with far advanced tuberculosis).

The following symptoms were most frequently associated with tuberculous tracheobronchitis: oral wheeze, asthmatoid attacks, difficult expectoration (with paroxysms of violent coughing), sputum irregularities (with variations between excessive amounts and periods of tenacious character), retention syndrome (intermittent fevers with brassy cough and symptoms of toxin absorption).

The following roentgenological findings were associated: pulmonary atelectasis (with and without collapses), tendency to unexpected and transient parenchymal infiltrations, evidence of partially obstructed cavity (having fluid levels). Eighteen of the 272 patients showed no roentgenologic evidence yet had positive sputa; of these, 9 had bronchoscopic evidence of tuberculous tracheobronchitis.

One hundred ninety-four patients showed neither clinical nor roentgenological criteria; 6 of these were found to have insignificant tuberculous tracheal or bronchial lesions; 26 had both symptoms and roentgenological findings and 15 of these were found to have tuberculous tracheobronchitis; 33 exhibited suggestive roentgenological findings but had no suggestive symptoms and 8 of these had tuberculous tracheobronchitis; 19 presented suggestive symptoms alone and only 1 had a tuberculous bronchial lesion.

Only 6 cases would have been missed if bronchoscopic examinations had been limited to those exhibiting supportive symptoms. They therefore believe that routine bronchoscopic examinations of patients with active pulmonary tuberculosis is unnecessary. Only those cases which present definite roentgenological or symptomatic indications are now subjected to bronchoscopy.

No prolonged deleterious effects were noted as due to the bronchoscopies.—*A. A. de Lorimier.*

Root, Howard F., and Bloor, Walter R. Diabetes and pulmonary tuberculosis, with special reference to the lipid content of diabetic lungs. *Am. Rev. Tuberc.*, June, 1939, *39*, 714–737.

Three hundred and sixty-four diabetic patients have been studied by the authors, in Boston and Rochester hospitals. Pulmonary tuberculosis was found to occur 12 times more often among juvenile diabetics than among all other pupils in Massachusetts grade and high schools. Forty per cent of deaths among diabetic children (having diabetes longer than ten years) were due to tuberculosis. The incidence of pulmonary tuberculosis among adult diabetics does not show a decrease in rate corresponding with the decrease of tuberculosis mortality in the general population. In 83 per cent of the cases, the tuberculosis appeared to follow the diabetes. The mortality from tuber-

culosis among diabetics shows no fall comparable with the falling rate among the general population (even allowing for the increase in longevity of diabetics). Eighty per cent of the group had indoor, sedentary occupations; exposures to metals or rocky dusts were rare. Most of the cases were over forty (only 10 per cent of all cases of diabetes begin in childhood—60 per cent after the age of forty). About 10 per cent of the group were Jews (likewise, 13 per cent in Joslin's series).

Of 126 cases studied by postmortem only 3 showed tuberculous lesions in the larynx and intestines; no case showed involvement in the meninges or brain. Pleurisy and effusions were rare. Caseation was the frequent finding, probably due to the disorder in fat metabolism (in caseation, there being a "coagulation of tissue protein associated with deposition of fat"). Tubercle bacilli were found in the sputum of diabetic patients in about the same incidence as among non-diabetics but the culturing characteristics of the organisms appeared modified—favoring growth. The blood cholesterol of tuberculous diabetic patients has been found to be elevated on the average, with lipoid deposits in the liver, spleen and other organs (and the development of atherosclerosis). Phospholipids appeared lowered.

The outstanding clinical finding was the rarity of meningeal lesions (especially prior to the advent of insulin). The only chance of discovering tuberculosis in a diabetic person in a reasonably early stage is to insist upon repeated roentgen examinations of the chest. Eighty-three per cent of the diabetics develop tuberculosis following the onset of their diabetes. Rapid loss in weight during months or years previous to the development of the pulmonary tuberculosis was a striking feature (of 219 cases, the average loss was 42 pounds). Twenty per cent were known to have had diabetic coma. The diet should include 150 to 200 grams of carbohydrates and 70 to 130 grams of fat with total calories based upon the handling of the diabetes rather than the pulmonary tuberculosis. Insulin requirements were less than for cases without tuberculosis. Protamine-zinc-insulin is especially to be recommended since it reduces the chances of shock and supports the weight.

The hope in these cases rests with the early recognition by the use of roentgen studies and then the treatment of the diabetes.—*A. A. de Lorimier.*

HAWKINS, J. L. H., JR. Tuberculous tracheobronchitis. *Am. Rev. Tuberc.*, Jan., 1939, *39*, 46–56.

For more than a century tuberculous involvement of the tracheobronchial mucosa has been realized. However, there has been some difference of opinion as to its incidence and effects. The author has found most of these lesions to be located on the posterior walls, submucosally. He believes that most of them develop first in the smaller bronchi, extending to the larger bronchi and finally to the trachea (22 per cent of patients with tuberculous tracheobronchitis were found to have tuberculous laryngitis while 50 per cent of those having the laryngitis were found to have lesions in the trachea and bronchi). The following types were observed: diffuse and nodular submucosal; ulcerative, and fibrostenotic.

In the Olive View Sanatorium, California, 516 patients were studied bronchoscopically. Of these, 132 showed gross evidence of tracheal or bronchial involvements. In most instances, the involvement was unilateral; 43 showed ulceration of a major bronchus; 27 showed extension into the trachea; 33 showed marked stenosis; 59 smaller lesions of the ulcerative or fibrostenotic type.

The following clinical evidence served as indications for bronchoscopy: asthmatoid attacks; oral wheeze; rhonchi; dyspnea out of proportion to vital capacity; excessive cough with tenacious sputum; constant tendency to non-productive throat clearing; persistently positive sputum with no other evidence of pulmonary tuberculosis—plus a willingness on the part of the patient to submit to the study and physical well-being sufficiently substantial to undergo it.

The following roentgenological evidence served to prompt these studies: narrowed trachea or bronchus (shown either with or without opaque oil); thickened bronchial walls; atelectasis; cavities which increase in size or which do not close with pneumothorax; cavities with fluid levels; large, round, thin-walled cavities; cavities with extensive perifocal reaction; hilar cavities; cavities or consolidations which appear and disappear and bronchogenic spread without visible cavity.

Six cases are briefly reported to emphasize the value of determining this type of lesion. The benefits of cauterization and dilatations are pointed out. For cauterizations, both 30 per

cent silver nitrate and high frequency currents were used; for dilatations, flexible bougies and cautery.

Complications which could be blamed on bronchoscopy were rare. Only 3 patients died within three weeks following the procedure (1 developing a spread of infiltration; 2 developing cardiac depression—all these were too sick for bronchoscopy).—*A. A. de Lorimier.*

Garvin, Curtis F. Lipoid pneumonia. *Arch. Int. Med.*, Sept., 1939, *64*, 586–589.

Pneumonias due to the aspiration of oily preparations were first described in 1925 by Laughlen. Most cases have been in children and the substances responsible have been such as: oily nose drops, mineral oil, cod liver oil and even milk and cream. Most patients have shown signs and symptoms of a low grade pneumonia (due to periodic exacerbations of secondary infections). Roentgen studies have visualized areas of increased density (particularly in the lower portions of the right upper lobe and the apical portion of the right lower lobe). Usually neoplasm and unresolved pneumonias have been considered. At autopsy there have been found cellular and histological reactions to the foreign substance, considerable fibrosis and content of oily substance. By 1936, 24 references to this condition were found in the literature.

The author is reporting 2 cases occurring among adults. The first was a woman, aged seventy-three, who had been treating herself because of a respiratory disturbance by using an oily salve which she allowed to trickle down her nasal passages. Roentgenography revealed a coarse mottled streaking in the lower mid lung fields which was interpreted as a pneumonic process. At autopsy, fat was found in vacuolated cells in the alveoli and free fat was found in the alveolar saccules and the septa. The second case was of a male, aged sixty-six, suffering with a carcinoma of the esophagus. He received mineral oil in his feedings. After presenting symptoms of respiratory infection, roentgenography revealed a mottled streaking extending from the left hilum. Autopsy studies revealed both free fat and phagocytosed fat in the alveoli and interstitial tissues.

In the first of these cases, the lipoid pneumonia was considered to be an important factor in the patient's death. It was unusual in that the aspirations seemed to have occurred in an otherwise normal individual. In the second case, the aspirations were likely due to the dysphagia. In both, the tissue reactions were the same as found in the infantile types of lipoid pneumonia.—*A. A. de Lorimier.*

Bradshaw, Howard H., and Chodoff, Richard J. Anthracosilicosis simulating pulmonary carcinoma. *Am. Rev. Tuberc.*, June, 1939, *39*, 817–824.

The authors present a case in which both the roentgenologist and the bronchoscopist gave consideration to the diagnoses: bronchogenic carcinoma and lung abscess. In the course of observation and treatment, roentgen therapy had been given but, there being no improvement after a period of over eighteen months the patient finally submitted to an exploratory thoracotomy. At operation the mass in the right hilar region felt hard and there were many hard hilar glands. Again, carcinoma was believed to be the correct diagnosis and a lobectomy was performed but the patient died. Biopsy and postmortem studies failed to reveal any evidence of carcinoma, showing merely pigment deposits and fibrosis—leading to the diagnosis of "anthracosilicosis with extensive fibrosis and consolidation."

The authors emphasize similarities in the manifestations of pneumonoconiosis and bronchogenic carcinoma. They contend that until the attitude of the medical profession toward exploratory thoracotomy approaches that which is current toward exploratory laparotomy, mistakes will happen.—*A. A. de Lormier.*

Trudeau, Francis B. Pleural effusion. *Am. Rev. Tuberc.*, Jan., 1939, *39*, 57–63.

For years it has been realized that pleural effusion in association with pulmonary tuberculosis tends to a benign course; this has been attributed to the compression of the lung by effusion.

This article deals particularly with those cases of pleural effusion where parenchymal lesions are not conspicuous—"simple pleurisy" cases. Of a total of 83 such cases, there was insufficient roentgen evidence to warrant a diagnosis of pulmonary tuberculosis; in 29, only slight parenchymal involvement, and in no instance extending below the second rib. Of the first group, there were relapses of tuberculous activity in only 4 cases, over a period of three to twenty-five years' observation; among the second group, only 8 relapses. In other words, 94 per cent of these cases were reported "well

and working" or "living," while only 6 per cent had died—and in none of these deaths was pulmonary tuberculosis reported to be the cause of the death (though tuberculous involvement of other organs were reported in 2 of the 5 deaths). These statistics are cited as evidence supporting the expression of favorable prognosis for this type of case—a prognosis practically as good as the normal adult population in the same age group.—*A. A. de Lorimier.*

GAETÁN, L. R. Accidental pneumoperitoneum. *Am. Rev. Tuberc.*, April, 1939, *39*, 537–539.

Eight cases of accidental pneumoperitoneum are listed; these represent an incidence rate of 1 to 11,000 artificial pneumothoraces at the Insular and Tuberculosis Sanatorium in Puerto Rico.

All happened after repeated attempts at the insufflations. One case occurred while refilling with 400 cc. of air, the needle being inserted in the fourth interspace and mid-axillary line. In no instance was intra-abdominal penetration realized by way of manometric pressures (which should be the reverse of those obtained in the chest, with inspiration and expiration). Symptoms such as pain in the epigastric region with radiation to one or the other shoulder, pain in the neck or pain in the xiphoid region were noted in 4 of the 8 cases; and subcutaneous emphysema, in 1 case. Two were diagnosed before roentgen studies but the diagnoses were established by fluoroscopy—which became routine after pneumothorax insufflations. No mortalities resulted from the accidents.—*A. A. de Lorimier.*

GROSS, ROBERT E., EMERSON, PAUL, and GREEN, HYMAN. Surgical obliteration of a patent ductus arteriosus in a 7 year old girl. *Am. J. Dis. Child.*, March, 1940, *59*, 554–559.

In their summary the authors state that a persistently patent ductus arteriosus after the first few years of life is an important cardiovascular abnormality which may lead to serious and even fatal complications in adolescence or adult life. The greatest of the impending dangers is subacute bacterial endocarditis. The next most important hazard is cardiac decompensation, which results from overwork of the heart produced by the arteriovenous communication.

Most patients with patent ductus arteriosus show little or no disability during childhood, but they are quietly laying the foundations for later trouble by building up atheromatous plaques in the pulmonary artery, which may later be the site of bacterial vegetations or else they are so overexercising the heart that decompensation may occur one or two decades later. If operative ligation of the ductus can be performed early in life, the degenerative changes in the pulmonary artery should be arrested and the danger of subsequent bacterial endarteritis should be decreased. Likewise closure of the arteriovenous shunt greatly reduces the work of the heart and should increase the cardiac reserve.

Four patients have been successfully operated upon without mortality and without complications. One is reported in this paper. After operation there was (1) a rise in the previously low diastolic pressure, (2) disappearance of the precordial thrill, (3) disappearance of all cardiac murmurs, (4) decrease in the size of the heart and (5) decrease in the work of the heart.

The teleroentgenogram of their patient showed a prominence of the left ventricle, fullness of the pulmonary artery, and congestion of the vessels in the lung fields.

The authors conclude that in properly selected cases surgical obliteration of a patent ductus arteriosus is a rational procedure which has much to offer the patient.—*R. S. Bromer.*

ABDOMEN

FIUMICELLI, F. Ernia diaframmatica destra traumatica. (Traumatic hernia of the diaphragm on the right side.) *Arch. di radiol.*, July–Oct., 1939, *15*, 496–503.

A boy seven years of age was run over by a truck. The prognosis was thought to be very bad. The hospital where he was examined reported a probable suprahepatic hematoma. The boy, however, recovered in twenty-five days. He was found to be underdeveloped both as to height and weight. Roentgen examination showed opacity of almost the whole of the lower right lung field. There was slight pain in the right thoracico-abdominal region. The opacity in the right thorax was surmounted by two large air-bubbles. The respiratory excursion, which was normal on the left, was much reduced on the right and paradoxical in character. There was roentgen evidence of fracture

of the third and fourth ribs between the middle and posterior axillary lines. The heart shadow was displaced to the left. The ascending colon and hepatic flexure lay above the liver and were continuous with the supradiaphragmatic air-bubble. The hepatic flexure did not show any stenosis or strangulation. A roentgenogram with the patient lying down showed the colon in almost normal position.

The diagnosis of diaphragmatic hernia was based on the interruption of the diaphragmatic line, the opacity beneath the herniated colon, the change in position of the colon when the patient lay down, the displacement of the heart and the paradoxical excursion of the diaphragm on the right side.

From the medicolegal point of view it is quite possible that this boy will suffer later from the injury. There may be complications on the part of the right pleura and lung which may be injured by the presence of the herniated colon or strangulation of the hernia may take place.

Cases of traumatic rupture of the right side of the diaphragm are rare for in the great majority of cases injuries which cause laceration of the diaphragm cause death. The author has not found any other cases in the literature.—*Audrey G. Morgan.*

Bonomini, Bruno. Invaginazione ileo-ceco-colica da lipoma sottomucoso. (Ileo-ceco-colic invagination caused by a submucous lipoma.) *Radiol. med.*, Nov., 1939, *26*, 1036–1040.

Roentgen rays are of value both in the diagnosis and treatment of intestinal invagination. The author describes a case in a man of forty-two who for fifteen years had had violent attacks of pain in the upper abdomen every two or three months. Barium was given by mouth and by enema. The roentgenograms are reproduced. They showed an ileo-ceco-colic invagination which had evidently been recurrent over a period of years. The cause of the invagination was found to be a small tumor in the last loop of the ileum a few centimeters from the valve of Varolius. Histological examination showed that this tumor was a submucous lipoma. The roentgen evidence of the presence of this small tumor had been a parietal filling defect with a large base, with distinct outlines, which could be moved slightly and its form changed. The small tumor could not be detected by palpation. The invagination could be reduced by irrigation with opaque liquid.—*Audrey G. Morgan.*

Baccaglini, Mario. Rilievi radiologici su di un caso di volvolo acuto del sigma. (Roentgen findings in a case of acute volvulus of the sigmoid.) *Radiol. med.*, Nov., 1939, *26*, 1031–1035.

A case is described in a woman of sixty-eight who a week before she came for examination began to have moderate pain in the abdomen lasting for two to three days. The abdomen began to distend and she had a feeling of weight. For seven days she had not passed gas or feces and enemas had no effect. She had no vomiting or fever.

Roentgen examination without contrast medium showed a great deal of gas in the small intestine; there were two levels of gas and liquid at the sites of the colon and sigmoid, one in the left iliac fossa and the other just above the pubis. An opaque enema was given which distended the normal rectum and ended in a cone which was elastic and contractile. The outline of the cone was not smooth but showed shallow sulci. When the pressure was increased somewhat the cone increased in size at the base but the liquid did not pass the obstacle. After evacuation the folds were of normal thickness and converged toward the apex of the cone with a helicoid course in the upper part. This picture is so characteristic that it may be considered pathognomonic of volvulus of the sigmoid.

Operation showed that the sigmoid had made a complete turn around its mesenteric axis.—*Audrey G. Morgan.*

Marzocchi, Gualtiero. Studio del transito del pasto opaco attraverso il colon nella stitichezza abituale. (Study of the passage of opaque paste through the colon in habitual constipation.) *Radiol. med.*, Dec., 1939, *26*, 1067–1103.

The author has previously made a study of the passage of barium through the normal colon; now he makes a comparative study of its passage in habitual constipation. He studied 41 constipated subjects, 30 of them women and 11 men; their ages were from thirteen to seventy-four years and they belonged to the intellectual as well as to the laboring classes.

He gave the patients a mixture of 120 gm. barium in 250 cc. water, and made roentgenoscopic examinations immediately after the paste was given, at the end of seven to eight hours, again after twenty-four hours and then

every twenty-four hours until the barium was completely evacuated. Two plates are given showing the evacuation of the barium in male and female subjects.

In normal subjects the barium does not have any effect on the evacuation of the intestine but in 34 per cent of these constipated subjects it hastened evacuation. This may have been due to the fact that the barium supplied roughage or that it irritated the slightly inflamed intestine.

The disturbance of passage in constipated subjects is practically uniform. There is slow progress of the opaque column throughout the colon, but particularly marked in the left colon, that is from the sigmoid flexure to the rectum. The author did not see any pure cases of segmental constipation, that is limited to a single segment of the bowel; and especially he did not see that form described by some authors in which there is normal passage through the rest of the colon with stagnation in the ampulla of the rectum. This form was seen combined with slow passage throughout the colon. It is possible that some of the cases of segmental constipation described by other authors were due to the fact that part of the food was not mixed with barium, so that stagnation in certain parts of the colon was not visible on the screen.

Only a few cases were seen in which the constipated intestine showed atony and spasm and these did not differ from the pictures seen in the normal intestine. It is hard to judge of the tonus of the intestine in constipation as tonus varies so widely under normal conditions. The author does not believe that the spasm seen in his cases represented a real obstacle to the passage of the food or that constipation can be classified into atonic, spastic and mixed forms.

In 41 per cent of the patients there was total or segmental dolichocolon, which suggests that perhaps there is an etiological connection between elongation of the colon and constipation. About 70 per cent of the patients studied by the author were distinctly of the longilinear type; this type seems to have a certain predisposition to habitual constipation.—*Audrey G. Morgan.*

SKELETAL SYSTEM

POTTS, W. J. Subperiosteal giant-cell tumor. *J. Bone & Joint Surg.*, April, 1940, *22*, 417–420.

Potts reports a case of a subperiosteal giant-cell tumor occurring in a boy of six years. It was located at the angle of the right mandible. He states that a careful review of the literature revealed no previous report of a subperiosteal giant-cell tumor of the skull or of the jaws. Geschickter and Copeland have stated that giant-cell tumors arise only in bone which is preformed in cartilage. To support this view they cited 22 cases of giant-cell tumor of the skull or jaws, all of which arose from those portions of bone which were preformed in cartilage. They predicted that, since the periosteum has osteoclastic activities, any giant-cell tumor arising from bone preformed in membrane should be subperiosteal. Potts believes that their prediction is fulfilled in the case he reports.—*R. S. Bromer.*

BAGOZZI, INNOCENZO CLERICI. Anomalie scheletriche numeriche e morfologiche in sede stiloidea e parastiloidea ulnare. (Numerical and morphological anomalies of the bones in the styloid and parastyloid region of the ulna.) *Radiol. med.*, Dec., 1939, *26*, 1104–1115.

Roentgenograms of the radiocarpal joint are very important in settling medicolegal questions concerning injuries in this region. One of the regions in which abnormalities are most frequently seen in such roentgenograms is that between the distal joint surface of the ulna and the upper border of the pyramidal and pisiform bones. In this region bones of various sizes are often seen, sometimes amorphous, sometimes distinct and with a fine bone structure, and in various locations with reference to the styloid process of the ulna. In some cases they occupy the site of the styloid process itself, which may be completely lacking or reduced to a small stump. In some of these cases the fragments can be seen to be due to an old fracture of the styloid process of the ulna which has not healed by bone callus; in other cases their traumatic origin cannot be demonstrated.

From this fact an argument has arisen as to whether supernumerary bones can be produced by an accessory center of ossification in the styloid process. The author concludes that these apparently supernumerary bones may originate in three ways: from fracture, from an accessory center of ossification in the styloid process, and from the persistence of certain embryonic cartilaginous structures which normally disappear on complete development. He describes and illustrates cases belonging to these three

classes and gives certain points useful in their differential diagnosis. Fracture fragments are always dislocated distally and toward the center of the wrist from the styloid process and their volume is proportional to that of the remaining stump of the styloid process. Bones originating from an accessory center of ossification are in the site normally occupied by the styloid process. The anomalous bone is equal in size to the styloid process of the opposite side, for this finding is rarely bilateral. These bones are generally triangular or conical in form.

Those originating from persistent embryonic cartilage are generally round or more rarely rhomboid in form.—*Audrey G. Morgan.*

De Bernardi, Ettore. Condromatosi articolare in un caso di infortunio. (Joint chondromatosis in an accident case.) *Radiol. med.*, Nov., 1939, *26*, 1012–1014.

A railway workman thirty-nine years of age was burned severely on the hands and face while handling benzine and inflammable oils. Multiple burns of the 1st, 2d and 3d degree were found. After seventeen days in the hospital he was discharged but had to carry his right arm in a sling for three months. He was then able to return to work but found that his capacity for work was decreased because of pain in the right forearm and slight limitation of movement. As time went on the movements of flexion and extension of the arm grew progressively less until he could not lift even the smallest weight.

Roentgen examination showed a number of free round bodies in the elbow joint; they were all of about the same size and of the density of osteochondromata. The head of the radius was slightly deformed and showed a small exostosis. All the other bones were normal.

Calcified osteochondromata of the joints are not extremely rare. They are not generally caused by trauma but the author believes that in this case they were caused by the burns and the consequent immobilization for three months. The heat probably caused an inflammatory reaction of the joint capsule or changes in the synovial fluid which resulted in the formation of the bodies. The roentgenogram was not taken until fourteen months after the accident. The small exostosis on the head of the radius might be used as an argument against this theory but no roentgenogram had been taken before and it is not known whether it existed before the accident. The author thinks the workman is entitled to compensation.—*Audrey G. Morgan.*

Fugazzola, Franco. Contributo all'interpretazione delle immagini radiologiche dette "zone di trasformazione ossea." (Contribution to the interpretation of the roentgen images of the so-called "zones of bone transformation.") *Arch. di radiol.*, July–Oct., 1939, *15*, 504–513.

Looser described certain zones of increased transparency in bone which he called "Umbauzonen" or zones of transformation. These have been quite generally attributed to old fractures. The author, however, studied 2 cases of such transformation zones in children with osteogenesis imperfecta. One was in a boy nine years of age who had had deformities of his bones since birth; the other was in a girl of ten in whom the first signs of the bone disease appeared when she began to walk. This case was under observation for five years and no signs of true bone reconstruction appeared.

These transformation zones are seen particularly in diseases in which there is bone dystrophy. There is lacunar absorption with substitution of a tissue with a reticulate structure; there are many fibers poor in calcium and necrotic tracts without any marked tendency to reconstruction of bone. These zones appear mostly in cases in which there is disturbed calcium metabolism but, on the other hand, disturbance of calcium metabolism may exist without the development of such zones. The appearance is that of transformation of normal bone into pathological bone rather than that of reconstruction of normal bone. In the author's cases the transformation zones appeared at the apices of the curvatures that took place in the bone and he thinks the changes are probably produced by abnormal functional demands made at certain points in the bone; possibly the continued trauma leads to disturbances of nutrition that produce the changes.—*Audrey G. Morgan.*

Bakwin, Harry, Bodansky, Oscar, and Schorr, Richard. Refractory rickets. *Am. J. Dis. Child.*, March, 1940, *59*, 560–570.

Cases of rickets in which extremely large amounts of vitamin D are necessary for cure are extremely rare. The patient reported in this paper was a boy who contracted rickets at the age of six years. The disease was characteristic, clinically and roentgenologically, and the blood

showed a marked reduction of phosphorus and increase in phosphatase. Almost all the calcium was lost from the body in the stools. Doses of vitamin D up to 40,000 units daily failed to cure the rickets. Examination of the blood while the disease was active showed that large amounts of vitamin D were being absorbed. With massive doses of vitamin D (1,000,000 units, equal to 100 cc. of viosterol) the rickets healed promptly. Withdrawal of vitamin D resulted in recurrence of the rickets. A daily supplement of about 440,000 units of vitamin D was necessary for maintenance.—*R. S. Bromer.*

CAFFEY, J., and SCHLESINGER, E. R. Certain effects of hemophilia on the growing skeleton. *J. Pediat.*, May, 1940, *16*, 549–565.

The authors report disturbances in epiphyseal development in 5 selected cases from a group of 11 juvenile hemophiliacs with joint involvement. In Case I the soft tissues about the involved left knee joint showed increased density with severe osteoporosis of the bones, more marked in the epiphyses than in the diaphyses. In the distal femoral epiphysis and the proximal tibial epiphysis there were several cyst-like areas of lessened density surrounded by annular linear areas of increased density. The intercondylar fossa of the femur was widened and deepened, and the articular facets of the tibia, especially the medial, were deepened. The joint space was considerably reduced at the periphery. In addition to these changes accelerated epiphyseal maturation was present on the hemarthrotic side. The same acceleration of epiphyseal maturation was noted in the left elbow joint which had been the site of recurrent hemarthroses. In Case II the increased density of the soft tissues and the osteoporosis of the bones was not marked but the epiphyseal maturation was pronounced. In this case there was also dysgenesis (flattening, cupping, and irregularity in density) of the center for the head of the radius. A cystic area was present in the diaphysis of the proximal end of the radius. Case III showed evidence of subperiosteal hemorrhage in the distal end of the humerus. There was no difference between the epiphyses of the two sides at this time but seven months later roentgenograms showed the capitellum of the radius on the affected side to be much larger than that of the uninvolved side. It also showed fragmentation and irregularity of outline and density. In Case IV the accelerated epiphyseal maturation in a hemarthrotic joint was present with no marked destructive changes in the bone or cartilage. Case V had a hemarthrotic hip joint with changes resembling Perthes' disease.—*R. M. Harvey.*

BULLO, ENZO. Angioendotelioma maligno della tibia. (Malignant angioendothelioma of the tibia.) *Radiol. med.*, Nov., 1939, *26*, 1043–1044.

A case of primary bone tumor in a young man, aged twenty, is described. It had begun about a year before with a feeling of weight in the left leg on walking. Soon after, a tumor developed at the head of the tibia and reached the size of a hen's egg. He had been operated on and the wound did not close. The roentgenogram taken by the author showed a process of combined destruction and production of bone that suggested malignancy but did not show the absolute diagnosis of the kind of tumor. The picture resembled in many respects that of osteosarcoma and differed in some respects from the classical picture of angioendothelioma. The periosteal proliferation with delicate barbs of bone tissue extending toward the soft parts, the destruction of the central part of the bone, and the presence of scattered spots of increased density suggested osteosarcoma. On surgical removal and histological examination, however, the tumor proved to be an angioendothelioma. —*Audrey G. Morgan.*

MUZII, MARIO. Eccezionale aspetto radiologico di una metastasi ossea di tumore epiteliale maligno. (Unusual roentgen appearance of a bone metastasis from a malignant epithelial tumor.) *Radiol. med.*, Dec., 1939, *26*, 1133–1137.

The author discusses the case of a man of fifty-eight who came for examination because of a hard tumor of the lower third of the left femur which had developed slowly. Roentgen examination showed a picture which seemed to be that of periosteal sarcoma; around the diaphysis of the bone there were little radiating spicules of bone resembling the barbs of a feather. Examination of a biopsy specimen, however, showed that the tumor was not a sarcoma but a metastasis of a malignant epithelial tumor, containing cylindrical epithelial cells.

There were also metastases in the glands of the hila of the lungs. The original tumor was not

found. It was possibly in the prostate. The patient died a few months later.

This case is important as showing that the classical picture of periosteal sarcoma may be caused by other forms of tumor. It is quite possible that other classical roentgen pictures may also be caused by other conditions than those to which they are commonly attributed. The value of the histological examination in this case was that it spared the patient an operation that would have been perfectly useless.—*Audrey G. Morgan.*

Miller, Leo F., and Arendt, Julian. Deformity of first metatarsal head due to faulty foot mechanics. *J. Bone & Joint Surg.*, April, 1940, *22*, 349–353.

Miller and Arendt report 3 cases which reveal the complete development of metatarsal deformity due to (1) sesamoid insufficiency or (2) weight-bearing directly on the first metatarsal head with subsequent minute repeated traumata, resulting in an aseptic necrosis. The histories of these patients revealed that they had had foot complaints for years with a relative lack of relief regardless of the type of treatment—pads, arch supports, special shoes, etc. In each case the distress was bilateral, and no other pathological changes of the joints or history of trauma could be elicited. All the patients were in the fourth or fifth decades of life.

The roentgenograms showed shortening of the first metatarsal, displacement of the sesamoids, irregularity of the cartilage with spur formation in the proximal end of the first phalanx, broadening and deformity of the head of the first metatarsal, increased thickening of the shaft of the first metatarsal, and spotted areas of decreased density in the distal end of the first metatarsal.

Miller and Arendt suggest that when these patients are first seen in the early stage, a protective mechanism should be applied to relieve strain and stress of dorsiflexion in the first metatarsal joint. The metatarsal bar should be of distinct advantage, as in each of their cases a varying degree of hallux rigidus was present. In one case, in which the hallux rigidus was so marked that regardless of the bar the patient still had distress, a bilateral partial phalangectomy of the proximal phalanx was performed, with definite improvement.—*R. S. Bromer.*

Fox, Theodore T., Burman, Michael S., and Sinberg, Samuel. An unusual case of tuberculosis of the spine. *Am. Rev. Tuberc.*, June, 1939, *39*, 825–829.

The authors are presenting a case of a colored male, aged twenty-five, who had slipped while carrying 150 pounds on his head, striking his back against the curbstone. Roentgenographic studies made shortly thereafter revealed a break in the outline of the upper posterior border of the body of the third lumbar vertebra, suggesting an incomplete fracture.

About a year later, this patient was studied again because of severe headache, vomiting and a semi-stuporous condition. Roentgenography at that time revealed conglomerate parenchymatous lobular infiltrations scattered throughout the right lung and the upper third of the left lung. Roentgenography of the spine revealed narrowing of the intervertebral disc between the bodies of the second and third vertebrae, evidence of an abscess cavity in the body of the third and a slight bulge of the psoas muscle. The patient died shortly thereafter and postmortem studies revealed: no evidence of fracture—old or new; narrowing of the intervertebral disc; destruction of the posterosuperior part of the third lumbar vertebra and replacement by yellowish-white caseated material with moderate osteosclerosis; slight destruction of adjacent portions of the second lumbar vertebra; bilateral psoas abscesses; tubercles in the myocardium, pancreas and other organs of the body (with no calcified lymph nodes or primary complex in the lungs).

The authors emphasize the importance of considering an inflammatory process in cases of back pain even though the pains might have been preceded by trauma; this warning is given particularly when roentgen studies are inconclusive.—*A. A. de Lorimier.*

Shapiro, B., and Tosti, V. G. Ventricular dilatation in spina bifida. *J. Pediat.*, March, 1940, *16*, 318–325.

The authors report 6 cases of spina bifida and meningocele, or myelocele, in each of which ventriculograms showed evidence of ventricular dilatation prior to operative interference. The cases ranged in age from five days to six weeks. In each case the head appeared grossly normal in all respects. Thirty cubic centimeters of spinal fluid was removed and 25 cc. of air intro-

duced. The article is illustrated with the ventriculogram from each case. The results bring up the obvious question as to whether ventricular dilatation is present in all children with even a mild degree of spina bifida and simple meningocele. This possibility has been suggested by Gross and Sachs who found hydrocephalus in 17 of 19 autopsies of non-operated cases. This tends to cast doubt on the theoretical advantage of preserving the sac at operation in order to retain its absorptive function and avoid disturbing the hydrodynamic of an unstable system.—*R. M. Harvey.*

TROTTER, MILDRED. A common anatomical variation in the sacro-iliac region. *J. Bone & Joint Surg.*, April, 1940, *22*, 293–299.

An articulation between the ilium and sacrum is described which is an anatomical variation. It is an accessory articulation which may be present singly, doubly, unilaterally, or bilaterally. Its cause and its effect are not fully understood. The articular facets which are parts of these articulations occur on the sacrum, in the region of the lateral sacral crest and on a level with the first or second posterior sacral foramen, and on the tuberosity which is the rough area above the auricular surface of the bone. The surface of the facets is mostly flat, but may be concave or convex with the opposing facet conforming. The peripheral outline is generally ovoid and irregular, with the longest diameter in a longitudinal plane and the shortest in a transverse plane. The average lengths of these diameters are 10 mm. and 8 mm., respectively. The accessory articulations occur in man in varying percentages according to race, sex and age. The articular surfaces may be covered with either hyaline cartilage or fibrocartilage. The posterior portions of the ilia are less widely separated in pelves presenting the variation than in those which are considered to be normal. Roentgenographic examination of the pelvis in the living has shown accessory sacroiliac facets in one case.—*R. S. Bromer.*

KING, DON, and RICHARDS, VICTOR. Osteochondritis dissecans of the hip. *J. Bone & Joint Surg.*, April, 1940, *22*, 327–348.

Osteochondritis dissecans is a non-infectious aseptic necrosis of a segment of subchondral bone of the long bones of the extremities, resulting ultimately, although not invariably, in an osseocartilaginous sequestrum into the affected joint. It occurs primarily in males in the second decade of life. The medial femoral condyle is the most frequent site of involvement, the capitellum being the next most frequent. Twenty per cent of the cases are bilateral.

The first reference in the literature to osteochondritis dissecans of the hip joint occurred in 1925 in an article by Haenisch. King and Richards report 2 cases and review the literature. There are no characteristic symptoms. According to most authors there are three definite stages in the symptomatology and course of the condition, (1) the latent, (2) painful, and (3) ankylosing, which are described in detail. The roentgenographic appearance of osteochondritis of the femoral head is so absolutely and unmistakably characteristic and completely unlike that of any other pathological process as to make its diagnosis absolutely certain. The typical location of the sequestrum is on the superolateral aspect of the articular cartilage of the femoral head above the round ligament. The lesion is sharply defined and punched out, with well-marked head, and rests directly upon it. The focus varies in thickness from 2 to 9 mm. and is rimmed with a sharp, clearly delineated, double-contoured margin, clearer than the subjacent femoral head. The entire femoral head is never involved; there is no flattening of the femoral head; and there are no changes in the femoral neck. Later, as the disease progresses into the arthritic stage, the clearly demarcated focus disappears and the changes of hypertrophic arthritis appear—thinning of the joint space, mild flattening of the femoral head, crenation of the acetabular rim and fine bony irregularities of the articular surfaces. In view of the high incidence of bilateral involvement, both hips must be examined roentgenologically. There are no known accurate roentgenographic studies demonstrating the details of the transformation from the sequestrated form to the arthritic form.

The etiology of osteochondritis dissecans in the hip joint, as well as that of the disease elsewhere, remains obscure. The main theories expressed are: trauma, vascular disturbance of the femoral head, constitutional and familial factors, and atypical rheumatism.

Dislocation of the femoral head from the acetabulum is necessary for proper visualization and removal of the osteochondritic focus. Oper-

ative intervention should be undertaken only after careful consideration. In neither of the authors' 2 cases did arthritis develop, although symptoms had been present for over twenty and ten years, respectively.—*R. S. Bromer.*

Beatty, George L., and Russell, C. A. Tuberculosis of the flat bones of the vault of the skull. *J. Bone & Joint Surg.*, Jan., 1940, *22*, 207–210.

Tuberculosis of the bones is a common condition, but tuberculosis of the flat bones, particularly of the skull, though an uncommon condition, is by no means a rare one. Less than 250 cases have been reported in the literature, and 50 per cent of all cases reported have occurred in children under ten years of age. The flat bones of the vault of the skull comprise about 1 per cent of all bone tuberculosis.

Males are probably more affected, because of trauma which is believed to be an etiologic factor. There is rarely a manifestation of a serious general tuberculosis, although it is almost always secondary to other lesions. The posterior cervical lymph glands are most frequently the primary focus, the tonsils being the port of entry. The frontal and parietal bones are most commonly involved. In the majority of cases the process extends first to the inner table of the skull, then to the outer table, and finally perforation occurs, with or without sequestration, depending upon the rapidity of bone destruction. A cold abscess forms at the site of the perforation, and the soft parts, which become elevated by pressure, may rupture spontaneously. Subsequent fistula formation occurs. The lesions may be single or multiple but they are always a part of the whole disease process. Single perforations are more common. Roentgenograms reveal the presence of a punched-out defect, definitely circumscribed by normal bone.

Beatty and Russell report a case which presents some of the characteristics of the disease. —*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

Wintrobe, Maxwell M., and Hasenbush, L. Lee. Chronic leukemia. *Arch. Int. Med.* Oct., 1939, *64*, 701–718.

The authors have reviewed 86 cases of chronic leukemia (39, myelogenous; 47, lymphogenous), studied and treated at the Johns Hopkins Hospital.

Of the myelogenous type, 61.5 per cent were males; of the lymphogenous, 83 per cent. In 72 per cent of the myelogenous, the onset was between the ages of thirty and fifty-nine (with the highest incidence between thirty and thirty-nine), whereas among the lymphogenous group, 61.7 per cent belonged to the age group fifty to sixty-nine (with the highest incidence between sixty and sixty-nine).

Among the myelogenous group (5 cases studied) some of the early evidence included unexplained leukocytosis, enlarged spleen, enlarged liver, slight adenopathies, increase in platelets (up to 1,200,000), decrease in red blood cells.

Comparable early studies among 16 cases, eventually proved lymphogenous leukemic, showed similar evidence (unexplained leukocytosis was the initial sign in a third of the cases) plus such findings as enlarged tonsils, enlarged prostates and glycosuria. Anemia and lymph node enlargements were noted at earlier stages among the lymphocytic as compared with the myeloid cases; the average time interval of recognition of the former, before definite symptoms, was 1.5 to 2.5 years, as compared with 2 to 5 years for myelogenous. Comparing the therapeutic effects it was found that roentgen irradiation was at least temporarily effective in a higher percentage of cases than was potassium arsenite.

From the time of recognition of the disease, 23 of 26 cases of myelogenous leukemia lived only 2.79 years while among the lymphogenous group, the span was only 2.33 years for 23 of 35 cases. The other cases are still living and there are cases on record having lived as long as twenty-five years.

The majority of cases did not show a remission of physical signs or derangements in the blood pictures, following infections; some showed decreases in the white cell counts. The lymphogenic group seem more vulnerable to infection.—*A. A. de Lorimier.*

GENERAL

Martin, Donald S., and Smith, David T. Blastomycosis (American blastomycosis, Gilchrist's disease). 1. A review of the literature. *Am. Rev. Tuberc.*, March, 1939, *39*, 275–304.

The diagnosis of *Blastomyces dermatitidis* infections is usually accomplished postmortem. It is too seldom considered, but careful studies for the fungus are indicated in chronic pulmonary infections when tubercle bacilli or other

organisms cannot be found for if specific treatment is started early enough the prognosis is not so grave.

In 1894, Gilchrist described double-contoured, round and oval organisms, considered to be yeasts in skin lesions. In the same year, Buschke and Busse described a yeast-like fungous growth in such lesions; the condition was considered "saccharomycosis." After obtaining biopsy studies, Gilchrist gave further description to the disease, calling it "blastomycetic dermatitis." This term has since been applied to these infections when caused by a fungous which grows as a mold. The authors would restrict this term to the "American type" and would apply the term "Cryptococcus" (Torula) to those caused by the more definitely yeast-like fungus which some are inclined to call "European blastomycosis."

They have reviewed 347 case reports, including 13 with which they themselves have dealt (only 80 of these can be considered proven). Evans reported a case of definite transmission from man to man—a needle puncture infection by an autopsy surgeon, which developed a "primary lesion" found to contain *Blastomyces dermatitidis*. Other similar cases have been reported. The natural habitat of the fungus is thought to be in nature, perhaps in damp cellars, moldy wooden buildings, animal fur, grass, brush and the like. Cases of systemic involvements have been reported from the ages of twelve to seventy. Strictly skin involvements have been reported in patients as young as six months. The ratio of males to females is about 9 to 1. The disease is far more prevalent among poorer classes. Cases have been reported from 28 states (the idea of prevalence in California is erroneous—more cases have been found in 19 other states); most seem to be located in North America, though the term has been applied extensively by South American observers. In 50 per cent the first symptoms were referable to the respiratory tract; 4 per cent were noted after an injury; 19 per cent by way of a skin lesion; 23 per cent by way of a subcutaneous nodule or abscess. Other early manifestations were chills and fever, generalized achings, toothache, difficulty in swallowing and pain in the epigastrium. Those with respiratory symptoms were usually considered as ordinary "colds" until there developed loss of weight, weakness, pains in the chest, etc. Productive sputum and hemoptysis were rather late in appearance. Tonsillitis, fever, bronchitis, dyspnea, night sweats and pleurisy have been reported. The first appearance of the skin lesions was as "pimples or pustules"—particularly on some exposed part of the body. In the systemic blastomycosis, the skin lesions are more widely disseminated (the strictly cutaneous type usually consists of a single slowly extending lesion). Histologically, the skin lesions resemble verrucous tuberculosis—there being extensive hyperplasia of the rete. The lungs are more frequently involved than any other internal organ. There, the pathology may be diffuse or of focal consolidations (resembling miliary tuberculosis). When cavities develop, they are seldom larger than 1 cm. The heart was found to be involved in 9 instances, with lesions in the pericardium, myocardium and endocardium. Bones and joints were infected in 50 per cent of the proved and presumptive cases, the vertebrae being most commonly involved, ribs next. The spleen and liver were involved in 24 cases; the pancreas in 4; the kidneys in 22; the gastrointestinal tract, rarely; the adrenals in 2 cases; the prostate in 11; the epididymis, seminal vesicles, uterus and tubes, occasionally.

Using as an antigen a saline suspension of blood agar cultures, complement fixations tests were done on 10 of the authors' 13 patients. Positive tests were obtained in 5 of these—of which 4 died. The authors believe that this test serves to indicate the extent of infection and also the homogenicity of the antigenic structure.

Skin sensitivity or "allergic type of reaction" has been considered because of the similarity of this condition to tuberculosis. The authors used 0.1 cc. of a heat killed vaccine, injecting intracutaneously. A specific reaction usually appeared in twelve to twenty-four hours, reaching a maximum in two to four days and not uncommonly breaking down into a sterile abscess. A state of anergy (negative reaction) was observed where there was overwhelming infection.

The mortality of systemic blastomycosis is higher than that of tuberculosis (of 59 definitely proven cases, 49 were dead within five years). In the case of strictly cutaneous infections, the record is of extreme chronicity.

Iodides, salvarsan, curettings, local applications of silver nitrate, bichloride of mercury, copper sulphate, phenol, cauterizations, freezings and roentgen therapy, all have been advocated. The authors have used vaccine ther-

apy in "subreacting doses," using the skin as a guide, injecting dilutions of 1:1,000,000 and beginning with 0.1 cc. and gradually increased every three or four days. Larger dosages were feared to produce focal and generalized reactions. After subduing the skin activities and the skin reactions, iodides were then administered and 2 cases showed healing even of pulmonary lesions.—*A. A. de Lorimier.*

Martin, Donald S., and Smith, David T. Blastomycosis (American blastomycosis, Gilchrist's disease). II. A report of thirteen new cases. *Am. Rev. Tuberc.*, April, 1939, *39*, 488–515.

The authors have previously analyzed 347 case reports of blastomycosis, as found in the literature. This present report deals with 13 cases which they themselves have studied. These cases are grouped according to their developments with the objective of emphasizing certain clinical and therapy aspects.

Three of these cases are examples of futile therapeutic efforts, probably because of the fact that the extent of invasion by the fungus was much out of proportion to body defenses.

A second group of 3 cases illustrate rapid spread of the disease during treatment with iodides. Characteristically, these cases showed positive serum complement fixations with organisms of *Blastomyces dermatitidis* isolated from their own lesions and immediate skin reactions (but no delayed tuberculin-like reactions).

The third group of 3 cases represented those seen relatively early when therapy should be expected to gain favorable results, but these cases failed to develop the necessary antibodies.

Another group of 3 cases received treatment with vaccine therapy and iodides and improved satisfactorily. These cases did show substantial antibody reactions (and one of them even showed a high titre of serum antibodies—the only case able to survive with such evidence. A complete hysterectomy was performed to remove a focus of the fungus and the patient was desensitized with vaccine therapy before starting the iodides).

The last case illustrates the relationship of allergy to both the protein and the carbohydrate fractions of the fungus. Intravenous injections of the carbohydrate fraction of *Blastomyces dermatitidis* were given with resultant decrease in the skin reactions. Iodides were then administered.

The authors emphasize the dual clinical characteristics of this disease: the cutaneous type (having chronic ulcerative processes) and the systemic (a highly fatal disease, characterized by pulmonary infection and widespread distribution of lesions in the subcutaneous tissues, bones, joints, central nervous system and internal organs). The same etiological agent is responsible in both types, the *Blastomyces dermatitidis*, though this agent may culture either as a double contoured yeast-like organism or as a typical fungus. The authors believe that the natural habitat for this fungus is in nature. Males are more often involved than females. Some patients develop sensitivities to the fungus, as demonstrated by skin reactions and this sensitivity decreases during the terminal stages of the disease. In cases which are heavily infected, antibodies may be found in the blood serum. Potassium iodide is curative in some cases but it is dangerous for patients who are allergic to the fungus. Therefore, for systemic blastomycosis, iodide therapy should be started only after the state of hypersensitiveness has been excluded by skin test or after it has been artificially reduced by injections of vaccine.—*A. A. de Lorimier.*

Mitchell, Edward C., and Goltman, David W. Progeria; report of a classic case with a review of the literature since 1929. *Am. J. Dis. Child.*, Feb., 1940, *59*, 379–385.

The term progeria, meaning prematurely old, was first given to a rare disease of childhood by Hastings Gilford who classified the disease as a distinct clinical entity. The chief characteristics of the condition are dwarfism, almost complete baldness, a beaked nose, a retracted chin, a narrow chest, prominent veins, arthritic changes, atrophy of the skin and subcutaneous tissues, obliteration of the normal depression of the umbilicus and peculiar brownish pigmented spots on the skin. In general, the patients present some features of a young person, but these are combined with many of the stigmas of old age.

Mitchell and Goltman report a case in detail. The roentgen examination of their patient, a white girl, ten years of age, showed a normal appearance of the skull except that it had a thin wall and the coronal suture was not closed. The sella turcica was normal. The ribs, clavicles, scapulas, pelvis and lower part of the spine had

developed normally although the bones were small. The epiphyses at both ends of the humeri were prematurely united with the shafts. Thickening of the cortex of both femurs was shown with outward bowing of the shafts and elongation of the necks which continued almost in a straight line with the shafts. This is a fairly constant finding in the classic cases. The phalanges showed premature union of all epiphyses, and the distal phalanges were cone shaped and appeared smaller than normal.

The authors believe from their review of the literature that theirs is the fourteenth typical case recorded. The cause of this rare morbid state is still unknown and the treatment is entirely empirical.—*R. S. Bromer.*

GROSS, ROBERT E. Neoplasms producing endocrine disturbances in childhood. *Am. J. Dis. Child.*, March, 1940, *59*, 579–628.

Gross presents a group of cases which point out the sexual, somatic and functional aberrations which are produced by tumors arising in the glands of internal secretion. Neoplastic diseases of the ovary, testicle, adrenal, medulla, adrenal cortex, pineal body and hypothalmic centers are individually considered and the clinical picture of each condition is described. He has limited the list to the neoplastic diseases of the glands of internal secretion which might possibly be alleviated or cured by surgical procedures. He has excluded those conditions which might be described as polyglandular disturbances and those in which it might be difficult to determine whether the individual patient might be exhibiting a family or racial characteristic in regard to the development of obesity, early appearance of puberty or exhibition of rapid skeletal growth. The endocrine disturbances resulting from the various types of neoplasms are illustrated by reports of representative cases. The bibliography covering each condition is complete.—*R. S. Bromer.*

BELLONE, ANGELO. Studio radiologico sulle tre logge osteoaponeurotiche del palmo della mano. (Roentgen study of the three osteoaponeurotic compartments of the palm of the hand.) *Arch. di radiol.*, July–Oct., 1939, *15*, 491–495.

The author made a roentgen study of the images produced by injecting opaque substance under the superficial palmar aponeurosis. He used this method because the opaque substance follows the same route as the pus in suppuration. He introduced the needle at the middle of the line passing under the pisiform bone and the tubercle of the navicular bone. The needle was stopped as soon as it could be felt to have passed through the middle palmar aponeurosis.

The aponeurosis of the palm of the hand is divided into three parts: the middle palmar aponeurosis and the aponeurosis of the thenar and hypothenar eminences. The middle palmar aponeurosis is very resistant and triangular in form. Its apex is directed toward the forearm and is continuous with the annular ligament of the wrist. From the deep surface of the triangular ligament two septa pass out at the boundaries of the thenar and hypothenar eminences, the first of which is attached to the anterior margin of the third metacarpal and the second to the anterior margin of the fifth metacarpal. They divide the palm of the hand into three distinct compartments: a lateral, a median and an intermediate. The largest of these is the intermediate one which is continuous with the canal of the wrist and through that with the forearm.

Roentgenograms are given of the course followed by the injected opaque substance. The liquid apparently enters into the thenar eminence but not into the hypothenar. The author supposed that the aponeurotic septum between the middle compartment and the thenar eminence must be less resistant than that between the middle compartment and the hypothenar eminence. But in the study of frozen sections of the hand he found that this was not true. The opaque fluid or pus does not pass through the septa but this effect is produced by the septa being pushed aside from the midline. The septum between the middle compartment and the thenar one is pushed farther because the muscles of this eminence are more yielding than those of the hypothenar eminence. The opaque fluid or pus does not pass from the middle compartment into either of the two lateral ones.

The author draws the conclusion from this that in incising for an abscess of the palm of the hand, the surgeon is not authorized in opening the thenar eminence even if the swelling extends into it. It is sufficient to evacuate the pus by an incision in the midline.—*Audrey G. Morgan.*

THORNDIKE, AUGUSTUS, JR. Myositis ossificans traumatica. *J. Bone & Joint Surg.*, April, 1940, *22*, 315–323.

Thorndike believes that myositis ossificans traumatica is an inflammatory process of muscle in its early stage and before ossification is actually demonstrated by the roentgen ray, the classical signs of "tumor," "dolor," and "calor" are present. This inflammatory process gradually subsides as ossification takes place.

The ossification is gradually absorbed in part and sometimes in full, depending upon its size and location. The muscle function returns to normal, except in those instances where the ossification occurs near a joint.

The pathological picture in sequence he believes is as follows: (1) a severe deep-muscle contusion, accompanied by tearing of muscle fibers and capillaries and the loosening of periosteal cells; (2) hemorrhage, with the accompanying inflammatory reaction that one would expect in hematoma formation; and (3) hematoma absorption, in which stage the ossification takes place. The latter occurs during the healing stage, and not during the acute hemorrhagic and inflammatory stage.

Treatment necessitates the immediate application of cold and a compression bandage to control hemorrhage, and later heat to aid in the absorption of the hematoma. The avoidance of massage on all severe and tender muscle contusions is of great importance. Operative removal of the ossification is indicated only in those cases in which it occurs near a joint in the origin or insertion of a muscle, where joint function is permanently impaired, and then only from twelve to twenty-four months after the injury.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

GAVAZZENI, ANTONIO. Risultati della roentgenterapia nei tumori della regione ipofisaria. (Results of roentgen therapy in tumors of the hypophyseal region.) *Radiol. med.*, July, 1939, *26*, 601–621.

There is still considerable difference of opinion between surgeons and roentgenologists in regard to the best treatment of tumors of the hypophyseal region. In considering the question the author describes 14 cases treated by roentgen therapy.

The technique used was that recommended by Béclère: irradiation of the sella from two temporal fields and one or two frontal fields; occasionally another small field is used at the nape of the neck or the vertex. At first about two treatments were given a week until quite a high dosage had been attained and then the effect was kept up by one or two irradiations a month for one or two years. Quite large doses were given over each field at each treatment—600 to 800 r. The time between series of treatments was regulated according to the progress of the case. Total doses of from 7,000 to 27,000 r were given in the author's cases. The adenomatous forms are the ones most amenable to roentgen treatment. Quite large doses should be given even in these with, of course, correspondingly larger doses in the other less sensitive forms.

There is no direct danger to the skin in this form of treatment and the nervous system is very tolerant of irradiation. In one of the author's cases epileptic attacks developed during one cycle of treatments and became worse in a later one. Some authors have reported symptoms of intracranial hypertension following irradiation but the author has never seen any such symptoms. Nor does radiotherapy render later operation any more difficult.

Among the author's cases there was great and permanent improvement in 4, or 29 per cent; partial permanent improvement in 3, or 21 per cent, partial temporary improvement in 2, or 14 per cent, slight improvement in 3, or 21 per cent and no improvement in 2, or 14 per cent. On the whole, therefore, there was great or moderate improvement in half the cases, in the other half there was only slight improvement or none at all. In the group of 10 cases with more or less signs of hyperpituitarism there were 4 marked and permanent improvements, 2 partial permanent improvements, 2 partial temporary improvements, and 2 slight temporary improvements; that is, success in 60 per cent of the cases and failure in 40 per cent. In the 4 cases of adiposogenital syndrome there was improvement persisting after eleven months in only one case; in the others there was no lasting gain from the treatment.

From a review of the literature and his own cases the author concludes that roentgen therapy with quite large doses is the treatment of choice, at least in the beginning, in all except cases with calcification and those in which there is imminent danger of blindness. In such cases surgery is indicated.—*Audrey G. Morgan.*

FERGUSON, ALBERT B. Treatment of osteogenic sarcoma. *J. Bone & Joint Surg.*, Jan., 1940, *22*, 92–96.

Ferguson's conclusions are based on a review of 400 cases of osteogenic sarcoma in the Regis-

try of Bone Sarcoma of the American College of Surgeons. Cases with inadequate data or seriously disputed diagnosis were excluded. There were 258 cases treated by amputation.

Early amputation is the treatment commonly urged for osteogenic sarcoma of an extremity. Ferguson believes that the results indicate that early amputation not only is not the best treatment, but it actually tends to assure the death of the patient. Early amputation is interpreted as amputation within six months of onset of symptoms. Survivors, he defines as patients living with no evidence of tumor at the last report more than five years after amputation and the last surgical treatment.

Within the first six months of amputation after the onset of symptoms the earlier amputations yielded the poorer results. With amputation in the first month after onset of symptoms, none of 13 patients survived. With amputation in the second month, 1 of 25 patients survived. In the third month, 2 of 23 survived. In the fourth, fifth, and sixth months together, 8 of 73 patients survived. He thinks there is no rational explanation for this, except that very early amputation is fatal. In regard to age period, he says the analysis might infer that a patient had practically no chance of survival following early amputation unless he was in the age period from eleven to twenty and unless the disease was located in the distal portion of the femur. Even at this specific site and in this age period, favorable to early amputation, results were slightly better after late amputation; 21 per cent survived early amputation, and 25 per cent survived late amputation.

Irradiation before amputation seemed to improve the results of early amputation (23 per cent surviving), but did not definitely affect the results of late amputation (25 per cent surviving). Irradiation alone did not effect a cure in any case of the series of 400 patients. Excision before amputation appeared to be a useful treatment. The results of early amputation were not notably affected by such incidents as biopsy, fracture, or incision and drainage.

Ferguson believes that it cannot be assumed that metastasis following amputation is principally due to the dislodging of tumor cells into the blood stream at the time of operation. It appears that the disturbance of the general circulation attendant upon amputation of the extremity is the aid which enables free tumor cells to leave the blood stream and to locate where they can grow in the pulmonary tissues. It has often been stated that the more distal lesions appear less malignant than the more proximal lesions. An amputation at the knee or midthigh causes less disturbance of the general circulation than does a disarticulation at the hip.

The lesions of osteogenic sarcoma do not grow constantly at an even rate. They have active and quiet periods. The cells tend to differentiate more during the quiet periods, but the less differentiated cells do most of the multiplying in the more active periods. The less differentiated, actively multiplying cells have the greater capacity to enter the blood stream and require less aid to leave the blood stream in the lungs where they can grow to form metastases. The early months of osteogenic sarcoma are always an active period in which amputation regularly results in metastasis. Later, there is at least some chance that the time selected for amputation is a quiet period during which the free tumor cells in the blood stream require greater aid than is offered by the amputation to enable them to leave the blood stream and to locate in the lung tissue. Hence, late amputation offers a better chance of survival than does early amputation and that chance will undoubtedly become greater when increased knowledge will make it possible to select a quiet period for amputation. This time might be that period when there has been no sudden increase of pain or of size for at least two months, no recent loss of weight, and when no extensive new development of destruction or soft-tissue mass is visible in the roentgenogram.

The idea that better results of late amputation might be due to the development of immunity or resistance to the tumor appears to be refuted by the results of early excisions. Early excisions yielded much better results than those performed more than six months after the onset of symptoms. Also, of the patients who died following late amputation one-third were dead within a year after operation; these patients can hardly be said to have developed resistance to the disease.

Ferguson in conclusion recommends the following treatment for osteogenic sarcoma of an extremity: (1) avoidance of early amputation; (2) delay of amputation; (3) irradiation before amputation; (4) irradiation, excision, and implantation of a bone graft or bone chips before amputation, with amputation following before

recurrence becomes evident; (5) repetition of excision before amputation, if recurrence is evident before amputation has been done.—*R. S. Bromer.*

Guidotti, Carlo. Terapia roentgen-diatermica in un caso di sindrome simpatico cervicale posteriore o morbo di Barré-Lieau. (Roentgen-diathermy treatment in a case of posterior cervical sympathetic syndrome or Barré-Lieau's disease.) *Arch. di radiol.*, May–June, 1939, *15*, 318–321.

A case is described in a man of thirty-two who came for roentgen diagnosis. About five months before intermittent headache had begun, chiefly in the occipital region, radiating to the parietal and frontal regions, the retro-orbital region and sometimes to the left shoulder. Later it became localized chiefly in the frontal region, the movements of the eyeballs became painful, the eyes tired easily and movements of the head were extremely painful. Finally, there was a loss of equilibrium, paresthesias of the limbs, and the limbs tired easily. General clinical examination gave very slight results. Roentgen examination showed a fissure of the posterior arch of the 7th cervical vertebra; there was also an abnormal implantation of the first left rib and bilateral high scapula or Sprengel's disease. There were no other malformations of the skeleton.

This fissure of the vertebra had produced post-traumatic, arthritic or rheumatic changes in the sympathetic nerve roots. The patient was treated by irradiation of a cervicodorsal field 6×6 cm., focus-skin distance 35 cm., filter 0.5 mm. copper and 2 mm. aluminum. An erythema dose was given, divided into ten treatments, using 170 kv. and 3 ma. These roentgen treatments alternated with diathermy treatments beginning at ten minutes and increasing to a maximum of twenty minutes, with plates of lead applied to the cervical and sternal regions. After twenty roentgen-diathermy treatments the patient was greatly improved and a month later he reported that he had regained his former good health.—*Audrey G. Morgan.*

Bullo, Enzo. Risultati della radioterapia dei melanoblastomi. (Results of radiotherapy of melanoblastomata.) *Radiol. med.*, Oct., 1939, *26*, 949–963.

There has been considerable difference of opinion in regard to the best treatment of melanomas and very great pessimism in regard to the effectiveness of any treatment at all. Most melanomas originate from congenital nevi which may be considered precancerous structures. There are, however, some primary cases. Nevi should be watched closely and the diagnosis of beginning malignancy is made from the history and an increase in the size of the pigmented areas.

The author discusses 29 cases which he has treated in the past ten years. They are divided into three groups: those treated by radiotherapy for metastases after surgical operation; those treated by surgical operation followed immediately by radiotherapy, and those treated by radiotherapy alone. He concludes that radiotherapy is to be preferred for melanomas of the face and trunk, while surgical removal is to be preferred for melanomas of the eye and of the fingers.

Among his cases the best results were obtained in the cases which were treated by radiotherapy alone. The percentage of cures in his group, including the cases with less than one year of observation, was 60 per cent; the average observation time was two years. Of course the results were also affected by the general condition of the patients which was not so bad in these cases as in the ones with metastasis. The percentage of cures in all three groups was 41 per cent; this is a very good result considering the poor general condition of some of the patients and shows that the general skepticism in regard to the treatment of these cases is not justified.

Among the cases with metastases only 1 in 13 survived, while among those without metastases 12 out of 17 survived, that is, 70 per cent. The prognosis is influenced not only by the presence of metastases but also by ulceration of the primary tumor, its extent and infiltration. In primary circumscribed tumors that do not show a great tendency to infiltration plesioroentgenography is the preferred treatment and in extensive and deep tumors radium therapy is to be preferred. In all cases, large doses are indicated because of the great resistance of melanomas to irradiation. In the treatment of metastatic glands some workers still prefer surgical removal followed by roentgen treatment, but the author thinks there is danger in the surgical removal of these glands in view of the fact that melanomas are disseminated by the blood. —*Audrey G. Morgan.*

FUGAZZOLA, FRANCO. Rendiconto clinico-statistico dell' attivita del padiglione nel quinquennio 1934–1938. (Clinical-statistical report of the work of the section of roentgenology, physiotherapy and radium therapy for the five year period 1934–1938.) *Arch. di radiol.*, Jan.–Apr., 1939, *15*, 51–71.

The author gives the statistical results of the number of roentgen examinations and the results of roentgen, radium and physical treatments in the Radiological Section of the hospital in Biella directed by Prof. E. Benassi. They show that there has been a constant increase in the number of cases examined and treated during the five year period covered. It is an interesting point that in almost all of the cases examined which required surgical treatment operation has confirmed the roentgen diagnosis. The statistics for gastric and duodenal ulcer and cancer show that there is only a small percentage of cancer as compared with ulcer. This suggests that while it is possible for ulcer to degenerate into cancer this probably does not happen very frequently. The work with new methods of treatment, as for example the Coutard treatment, shows that the improvement brought about by these methods well repays the expenditure of time and money required to carry them out.—*Audrey G. Morgan.*

ANZILOTTI, ALBERTO. Su alcuni problemi nel trattamento delle sindromi ipertiroidee. (Some problems in the treatment of hyperthyroid syndromes.) *Radiol. med.*, Nov., 1939, *26*, 987–1012.

There is still a great deal of discussion as to whether surgical or roentgen therapy is to be preferred in hyperthyroid conditions. A distinction is made between primary exophthalmic goiter appearing in young people after trauma, violent emotion or influenza, and Basedow symptoms appearing late in older people after they have had enlarged goiter for a long time.

The author believes that roentgen treatment is indicated in certain classical cases of Basedow's disease, in cases in which surgical treatment is contraindicated, in the preoperative treatment of cases in which operation must be deferred for any reason. In classical cases of Basedow's disease irradiation is indicated in mild initial cases, cases in patients less than eighteen years of age, inoperable cases and in recurrences after operation.

In addition to direct irradiation of the gland, irradiation of the cervical sympathetic is often indicated. Irradiation of the cervical sympathetic is always indicated in association with irradiation of the thyroid but it is particularly indicated in all classical cases of Basedow's disease, in Basedowoid cases at puberty, as described by Potozky, in Stille's Basedow neuroses, in the hyperthyreoses of the climacteric and in the forms of sympathetic disequilibrium without hyperthyroidism described by Delherm and Beau.

The indications for surgical treatment are in cases in which roentgen treatment has failed, in Basedow adenomata, in cases which are progressing rapidly and in all forms stubbornly resistant to treatment.

It was formerly believed that irradiation caused adhesions which interfered with later surgical operation. This, however, was based on subjective impressions rather than on actual observation or experimental work. Research has tended to show that when adhesions occur they are due to the growth of the goiter rather than to the action of roentgen rays. The author made a histological study of 2 operated cases, one of which had been irradiated before operation while the other had not. Adhesions were found in the non-irradiated case and none in the irradiated case. The adhesions were evidently due to connective tissue hyperplasia resulting from growth of the goiter.

When adhesions do occur after irradiation, the author believes they are caused by the technique used rather than by the mere fact of irradiation. He believes that large doses of soft rays, such as used by the Viennese and French schools, tend to cause adhesions, while fractional doses of harder rays do not do so.

He gives statistics from the literature of various countries which show that there is recovery or very great improvement in about 80 per cent of the cases treated by irradiation. This is as good as or better than the statistics for surgical treatment and there is the added advantage that there is no primary mortality while the operative mortality in surgery is still quite high.—*Audrey G. Morgan.*

LAHM, W. Zur Diagnose und Behandlung der Mediastinaltumoren. (Diagnosis and treatment of mediastinal tumors.) *Strahlentherapie*, 1940, *67*, 185–204.

In his discussion of mediastinal tumors the

author includes only lymphogranulomata and lymphosarcomata. As late as 1900 the textbooks said little about mediastinal tumors except that they are of great clinical interest but very soon cause death in spite of all treatment.

The author describes 12 cases which he has treated with roentgen irradiation. Differential diagnosis must be made from other conditions that cause enlargement of the mediastinum, such as substernal goiter, dilatation of the esophagus, aortic aneurysm and mediastinitis, and from tumors which are not mediastinal tumors in the strict sense of the word, such as hyperplasia of the thymus, cysts, exudates, tuberculous glands, carcinomata of the bronchi, etc. Differentiation must be made between lymphogranuloma and sarcoma. In the beginning both are almost symptomless. Such tumors are suggested by long-continued irritating cough, rush of blood to the head, shortness of breath, paresis of the vocal cords and neuralgias of obscure origin in the brachial plexus or thoracic segment when no special cause for these symptoms can be found in the circulatory or respiratory organs. If there is, in addition, enlargement of the spleen, slight anemia, itching of the skin, undulant fever and sweating, roentgen examination is necessary to clear up the diagnosis. Most of these symptoms belong to lymphogranulomatosis in general, and only signs of compression of the mediastinal organs are characteristic of the mediastinal localization. If these signs are accompanied by a blood picture of lymphocytosis and lymphopenia, 10,000 to 40,000 white cells, lymphocytes 3 to 15 per cent, leukocytes 75 to 85 per cent, the disease is pretty certainly lymphogranuloma. The lymphopenia disappears during remissions; it gives way to a lymphocytosis in border line cases which are probably lymphatic leukemias.

The diagnosis can also be verified by a test irradiation. An irradiation of 200 to 300 r over the mediastinal glands generally causes no change for the first three to five days in lymphogranuloma. Sarcomata may disappear very quickly, also leukemic or subleukemic lymphadenoses. But in ten to twenty days the irradiation shows a decided effect in lymphogranulomata also.

The amount of irradiation to be given depends on the condition of the patient in the individual case. Details are given in the description of the cases. Patients who are in very poor general condition cannot of course stand very large doses. The effect of the first irradiation must be very carefully observed and the succeeding doses made dependent on the reaction. In all of the cases described death finally occurred. In one of the cases the disease was refractory to the rays from the first, but in all the other cases there were excellent palliative results and life was lengthened by as much as four and a half years. It is known that patients with lymphogranuloma can sometimes be kept alive for ten years by systematic irradiation, but a lengthening of life for four and a half years is rare in mediastinal tumors.

The first dose must be chosen carefully for too large a dose in the beginning may cause signs of pressure. An attempt should be made, however, to give destructive doses from the beginning. The author irradiated the different fields with 200 to 300 r at intervals of two to three days until doses of 900 to 1,200 r had been given. More than 500 to 600 r was never given at one treatment, especially when fields larger than 10×10 cm. were used. Sometimes 1,100 to 1,800 r was given in ten to fourteen days and the higher dosage seemed to give better results than long-continued weak irradiation.

The object of irradiation is first a local palliative result and then prevention of local recurrence and generalization. Local recurrence can generally be prevented but generalization takes place finally.

The blood picture approaches normal after irradiation in cases with a good prognosis; low leukocyte counts in the beginning of the disease indicate an unfavorable prognosis. In the terminal stage, the blood picture may change and resemble that of an aleukemic lymphadenosis with high lymphocytosis.

Arsenic treatment should be given in connection with or following the roentgen irradiation.—*Audrey G. Morgan.*

Cervera, Leandre, and Torres-Carreras, R. Hypophysodystrophia mit diabetes insipidus. (Dystrophy of the hypophysis associated with diabetes mellitus.) *Strahlentherapie*, 1940, *67*, 339–346.

The authors describe a case in a youth seventeen years of age who showed the picture of adiposogenital dystrophy and diabetes insipidus. He was given roentgen irradiation as follows: July 2, 150 r over the right temple; July 9, 150 r over the left temple; July 16, 130 r over

the right temple; July 26, 100 r over the left temple; August 9, 130 r over the occiput; August 16, 130 r over the interparietal suture; August 30, 130 r over the upper anterior frontal bone; September 6, 130 r over the upper anterior frontal bone. Total dose 1,050 r. The technique was 180 kv., 4 ma., fields 6×8 cm., focus-skin distance 35 cm., filter 0.5 mm. copper and 2 mm. aluminum.

The patient bore the treatment very well. Pubic hair appeared, he grew 3 cm. in height and part of the fat disappeared. The polyuria persisted, however, and the patient continued to wet the bed. He was then given 10 mg. thyroxin daily and showed further improvement and growth. It required psychic treatment, however, to overcome the bed-wetting.

The authors have been using this technique of treatment for thirteen years and have found it effective in three clinical conditions which apparently are quite dissimilar: Fröhlich's adiposogenital dystrophy, Simmonds' cachexia, and diabetes insipidus. In cases of simple hypofunction of the hypophysis, roentgen treatment alone is sufficient; if there is also thyroid dysfunction thyroid extract must be used also. Cases like the one described above represent a combination of prehypophyseal and hypogenital symptoms, and in such cases a combination of roentgen therapy and treatment with sexual hormones is indicated.

The author believes that in cases of delayed puberty from partial or total defect of the hypophysis, there is no other method of treatment to be compared with weak roentgen irradiation.

Bauer holds that all processes of hypofunction of the hypophysis in childhood are automatically compensated when puberty is reached. But as puberty is normally reached in Germany by boys at fourteen to fifteen years of age and by girls at thirteen or fourteen, treatment of such cases of hypofunction of the hypophysis should not be delayed beyond that age.—*Audrey G. Morgan.*

BIGNAMI, CARLO. Modificazioni del quadro ematico in seguito a roentgenterapia a 350 kV. (Changes in the blood picture after roentgen therapy at 350 kilovolts.) *Radiol. med.*, Nov., 1939, *26*, 1015–1030.

Irradiation with progressively higher tensions has been used with increasing frequency in recent years, especially in the treatment of carcinomata of the female genitalia, the esophagus, rectum and bladder. This method is called gamma roentgen therapy. It has been feared that this method might injure the general health of the patients as large doses are used with heavy filtration, long focal distance and large fields often involving extensive areas of bone. For this reason the author made a study of the blood in a large group of patients with carcinoma of the uterus treated by this method.

His technique was as follows: 350 kv., 4 ma., filter 1 mm. copper and 1 mm. aluminum, half-value layer 4.32 mm. copper, focus-skin distance 80 cm., illumination 9 r/m, two fields of 320 sq. cm. Over each field 3,000 r was given in fractions of 150 r per day, the normal dose of 6,000 r being reached in 40 treatments.

Radium treatment inside the uterus had been given before the beginning of the roentgen treatment. Blood examinations were made before and after the radium treatment and before and immediately after the roentgen treatment and then after intervals of one week, two weeks, one month, two months and three months.

The examinations showed a considerable decrease of red cells in the beginning and also of the amount of hemoglobin with increased color index; this was followed by an increase in these values after two months, but they had not returned to normal even after three months. There was a marked leukopenia in the beginning followed by a slight increase, but the values had not returned to normal at the end of three months. The leukopenia was characterized by a severe absolute and relative lymphopenia with a considerable neutrophilia and a relative eosinophilia. The number of basophil polymorphonuclears and monocytes varied in different cases and according to the time when the examination was made. There were no morphological changes in either the red or white cells and no immature forms were seen.

The changes in the blood seen after irradiation at 350 kv. were not any greater, according to the author's observation, than those after treatment at a tension of 170 kv.—*Audrey G. Morgan.*

GIORDANO, GIOVANNI. Comportamento del tasso glicemico in cancerosi sottoposti a "superteleröntgenterapia." (Course of the glycemia curve in cancer patients treated by superteleroentgen therapy.) *Radiol. med.*, Dec., 1939, *26*, 1116–1130.

In superteleroentgen therapy the patient is placed between two tubes at a distance of 7 or 8 meters from each other so that he is subjected to irradiation from above and below from a distance of 3.5 to 4 meters. The irradiation may be general over the whole body or given only over large fields. The author used both methods in his study of glycemia in superteleroentgen therapy and did not find any essential difference in the effect of the two methods.

He studied 12 cases in all of which the diagnosis had been confirmed by histological examination. Glycemia was determined twenty-four hours before the beginning of treatment and twenty-four hours after, and later at intervals of four or five days until the end of treatment.

Curves showing the details of the effect on glycemia are given. In general, they show an increase in the first twenty-four hours of treatment, followed by a decrease for several days to values that were very low in some cases. Then on the eighth, tenth or even twelfth day in some cases there was a second increase, less than the first but which in some patients brought the values up to above what they were in the beginning. After that there was a progressive decrease, generally to normal. As in most cancer patients the values had been above normal in most cases before treatment.

These results differed somewhat from those after the usual methods of roentgen treatment. It is hard to compare the results of different authors because they were found under such different experimental methods and with such different classes of material. But, in general, with the ordinary method of treatment there is no second rise, but a progressive decrease to normal. The general effect in all methods of roentgen treatment, however, is to restore the glycemia values to normal.—*Audrey G. Morgan.*

Moscariello, Tullio. Note sulla terapia del carcinoma del retto. (Notes on the treatment of carcinoma of the rectum.) *Arch. di radiol.*, July–Oct., 1939, *15*, 514–528.

The author discusses the various methods of treatment of carcinoma of the rectum—radical surgical operation, palliative surgical operation by the establishment of an artificial anus and the various methods of radium and roentgen therapy. He then takes up 57 cases of his own treated by radium. They were all cases that were so far advanced that radical operation was impossible and some of them had refused the establishment of an artificial anus. Eight of them had been operated on before their condition became so serious and 5 had had artificial anus. They were therefore in a much more desperate condition than the cases ordinarily reported in surgical statistics. He believes that all operable cases of cancer of the rectum should be operated on but tries to show from these cases that the prospects, even in inoperable cases, are not nearly so hopeless as is generally assumed.

He gave radium treatment either by fixation with needles or by inserting in the rectum tubes or needles containing radium and supplied with filters. Of the 5 who had had artificial anus established 2 survived for a year and one for two years; 2 were not followed up. Of the 8 cases of recurrence 4 survived one year, 2 two years, 1 four years, and 1 was not followed up. Among the other 44 cases, 9 survived less than one year, 18 for one year, 4 for two years, 2 for three years, 2 for four years, 2 for five years, 1 for more than ten years—in fact he is still living after eighteen years. Considering as cured only those patients who lived for more than four years, 6 were cured, or 10.52 per cent.

The cases which gave the poorest results were those of cylindrical epithelioma, while the cases of pavement epithelioma showed better results, both locally and with reference to length of survival.—*Audrey G. Morgan.*

Marks, M. B. Hypersensitivity to sulfanilimide following roentgen therapy. *J. Pediat.*, April, 1940, *16*, 503–506.

Sensitization symptoms to strong sunlight and ultraviolet rays has been reported following sulfanilimide therapy. The author reports 2 cases in which these symptoms occurred following roentgen therapy. Both cases were patients with cervical adenitis whose local and general symptoms became markedly worse on exposure to small doses of 75–100 r of roentgen therapy with concomitant sulfanilimide therapy. The sensitization was still present in the first case several days after drug therapy had been discontinued.

The author concludes that sulfanilimide therapy is a definite contraindication to roentgen therapy or exposure to strong sunlight for a considerable interval of time after its discontinuance. In view of the widespread use of sulfanilimide and its derivatives, it will be interesting to see if these findings are verified by other observers.—*R. M. Harvey.*

LOEBELL, H. Die Radiumbehandlung des Schleimhautlupus. (The radium treatment of lupus of mucous membranes.) *Strahlentherapie*, 1940, *67*, 335–338.

As neither rhinolaryngologists or dermatologists seem to be using radium very much in the treatment of lupus of the mucous membranes, the author judged it worth while to give some details in regard to the methods used for the past fourteen years in the throat, nose and ear clinic of the University of Münster.

Contact irradiation is the best method. This can be carried out without any great difficulty in the nose, as the radium carriers can be applied to the diseased place and tamponed there under direct vision. Brass tubes, or more rarely gold or platinum ones with walls 1.5 mm. thick serve as filters and guarantee irradiation in all directions. If only the septum or the turbinates are to be irradiated the radium is placed in a lead case, the removable cover of which consists of a platinum filter 1 mm. thick. In lupus of the posterior part of the nasal cavity tube filters 4 to 5 cm. long are used.

For irradiation in the nasopharynx bent sounds the shape of an ear catheter are used, to the front of which the short tube filter is fastened. This is illustrated. The carrier can be fixed in any desired position by means of a wire fixed by a circular slide to the sound and fastened to the outer side of the nose with adhesive plaster. Formerly the radium was introduced through the mouth but this was given up because of the discomfort to the patient.

In treatment of lupus of the mouth and mesopharynx also the radium carrier can be fastened to the teeth with wires and applied to the diseased spot by bending the wires. But this, too, has been given up because of the trouble and expense. For some years the author has used paste for the fixation of the carrier. The mass is softened in warm water and a mold of the teeth made. The wire holder of the carrier is pressed into this while it is soft and the whole thing placed between the patient's teeth before it is cold. The patient bites into the paste and this gives sufficient firmness. No special holding wire is necessary if the lupus spots are on the gums or the floor of the mouth. In these cases the tube filter can be pressed directly into the paste. The prostheses can be taken out at night and at meal times. Direct radium irradiation of the larynx has not proved successful.

Though no absolute rule for dosage can be given, Berger's dose of 70 milligram-hours for each square centimeter of diseased mucous membrane with a brass filter 1 mm. in thickness had proved effective. If there are many granulations they should be removed surgically.

From 1925 to 1938, 253 patients were irradiated by this method among the 305 cases of lupus observed. In 49 cases the radium irradiation was repeated because of a recurrence. Among the 196 patients who were cured 164 were treated more or less exclusively by radium. In all except 47 of these cases the observation time has been five years or longer. Foci of lupus on the hard palate and in the anterior part of the nose reacted particularly well. Frequently salves had to be used for dryness of the mucous membrane for the first few weeks after the irradiation. No injuries were observed except this dryness and scab formation.—*Audrey G. Morgan.*

KÖRBLER, JURAJ. Zur Radiumbehandlung vernachlässigter Hautkrebse. (Radium treatment of neglected skin cancers.) *Strahlentherapie*, 1940, *67*, 551–552.

A number of writers are cited who believe that radium treatment of skin cancers should be preceded by electrotomy. Arzt advocates this method because he says that treatment with radium alone requires too long a time—several months to a year. The author thinks this is due to the method used by Arzt for ordinarily skin cancers can be cured in six to eight weeks with radium treatment alone. Arzt used fractioned doses of 70 to 80 per cent H.E.D. with intervals of one to two days and this treatment was repeated five to eight times.

As evidence of his claim that even large and badly neglected skin cancers can be successfully treated with radium alone the author describes a case.

The patient was a woman of forty-seven who had suffered from skin cancer for seven years. The whole nose and the adjoining skin of the face was involved in the tumor. The patient had never been treated. Histological examination showed basal cell cancer. First radium needles were inserted to decrease the size of the tumor and stop the continuous bleeding. The dose was 890 mg. element hours, filtered through 0.5 mm. platinum. When the tumor no longer decreased in size another histological examination was made which showed pavement cell carcinoma. Two months after the first irradiation, a second

irradiation of the remaining tumor was given, a contact irradiation with radium tubes containing 3 mg. The dose was 1,730 mg. element hours, using a 1 mm. platinum filter. Two months after this treatment almost all of the tumor had disappeared, leaving only some foci around the edge. These disappeared after another contact treatment. On examination a year later a soft scar had developed which hardly disfigured the patient's face at all.

On the basis of such cases as this, the author thinks radium should be tried first in such cases. If electrosurgery is necessary it is better to use it after the irradiation for any parts of the tumor that may remain or for beginning recurrences. In renewed irradiation of such residual parts of the tumor there is danger of injuring the adjacent healthy skin.—*Audrey G. Morgan.*

Vollmer, H. Treatment of rickets and tetany by parenteral administration of one massive dose of vitamin D. *J. Pediat.*, April, 1940, *16*, 419–432.

The shock treatment of using massive parenteral doses of vitamin D has been generally accepted in Germany. Between 600 and 700 cases have been reported with no instance of toxicity. However, the pure vitamin D_2 or D_3 must be used. Either of these vitamins has been administered by the author. The dose is 600,000 units which represents one-fifth the calculated toxic dose. Rachitic patients will retain 97 per cent of such a large single parenteral dose.

The author injected this dose in 158 patients, both rachitic and tetanic, and in no case were any toxic symptoms noted nor did calcium-containing casts form. The dose was administered in an oily solution with ether added to promote absorption. In rachitic cases the serum calcium rose to normal within three to seven days. Calcium deposition could be seen in the roentgenograms within a week and was usually complete within a month. Tetanic convulsions ceased within twenty-four hours.—*R. M. Harvey.*

MISCELLANEOUS

Brailsford, James F. Simple radiographic methods for the localisation of foreign bodies. *Brit. J. Radiol.*, Feb., 1939, *12*, 65–75.

The one way to learn localization of foreign bodies is to master a few simple principles; then accompany every case which has been localized to the operating theatre and witness the extraction of the foreign body, the whereabouts of which has previously been defined in the roentgenologist's report.

For success, no matter what method is employed, certain essential requirements must always exist: (1) cooperation between the surgeon and roentgenologist; (2) fixation of the patient on the operating table in the position used for localization.

Once the position of the foreign body has been determined, the patients should be fixed in the position to be repeated on the operating table, and all subsequent roentgenograms, in different planes, obtained by movement of the roentgen tube.

Routine Procedure. A single anteroposterior roentgenogram is taken with a metal pointer resting on the film and pointing to the wound. This film gives the relative position of the foreign body to the wound. Over the site where the foreign body is judged to be situated, metal markers are fastened to the skin with adhesive plaster and additional anteroposterior and lateral roentgenograms are taken. Two, three or four markers may be necessary. On examining these roentgenograms showing the position of the foreign body relative to the metal markers, one can decide the best route by which the foreign body can be extracted. The limb is now placed in the optimal operating position and further anteroposterior and lateral roentgenograms are taken with the tube centered over the metal markers. The author then makes a small cross "+" on the skin under that portion of the marker which the roentgenograms show to be overlying the foreign body. He uses a sharp scalpel to make this cross on the skin and paints it over immediately with iodine.

When the foreign body is situated in such position as to make impossible an accurate estimation of its depth and relation to neighboring bony structures by anteroposterior and lateral roentgenograms, a modification of the triangulation methods used by Mackenzie Davidson is used.

The roentgenologist's report should state, in addition to the depth of the foreign body, its relation to any important anatomical landmarks which will be encountered or which may serve as a guide at the operation.

The author advises recreation of the foreign body's position in the body by means of plasticine fixed in the bony skeleton to better guide the surgeon during the operation.

To facilitate removal of foreign bodies from bone Brailsford advises the making of roentgenograms in such a manner that the localizing markers are not overlying important vessels. At operation the surgeon, previous to making his incision, pushes a needle from the mark in the direction of the central ray of the roentgen tube down to the bone, fixing it there with a little pressure. He can then dissect down to the needle and extract the foreign body.

To trace out the course of a sinus caused directly or indirectly by entrance of a foreign body, a mixture of 25 per cent bismuth carbonate in vaseline is used. This is heated up and the powder is stirred into the liquid vaseline. While still liquid it is drawn into a syringe and allowed to cool. Then the mixture is injected. Fluid would readily escape at the mouth of the sinus and fail to extend into its depths, whereas the bismuth paste is injected in the form of a core which will readily track out the sinus. The author stresses the value of roentgenography of foreign bodies in detecting early evidence of wound infection by the anaerobic gas-forming organisms of gas gangrene.—*S. G. Henderson.*

SHAY, HARRY; GERSHON-COHEN, JACOB; FELS, SAMUEL S.; MERANZE, DAVID R., and MERANZE, THEODORE. The thymus; studies of some changes in the gonads and pituitary following its destruction by roentgen irradiation. *J. Am. M. Ass.*, Jan. 28, 1939, *112*, 290–292.

The rat was used as an experimental animal for this work. The exposures were made anteriorly through the superior mediastinum. Treatments were given daily and were begun when the rats were forty-eight hours old. The average dose was 550 roentgens and was administered on four successive days. The animals were immobilized, and the center of the portal was determined by roentgenoscopic examination and indicated by an ink mark on the skin. The portal was from 8 to 10 mm. in diameter. The rest of the animal was properly protected by a lead sheet. With this amount of radiation, atrophy of the thymus occurred rapidly and in most instances was so complete that no thymic tissue could be recognized at autopsy.

Authors' Summary. The complete or nearly complete destruction of the thymus early in the life of the rat results in an arrest of development of the spermatogenic portion of the testes. This physiologic castration is accompanied by the development of a typical castrate pituitary picture. These changes are progressive to approximately the age of 100 days, the time when the thymus in the rat has reached the peak of its growth. During this period all males with destruction of the thymus remain sterile. After this period reparative processes set in so that in fifty to a hundred days more the testes have completely regenerated, the pituitary has returned to its normal state and the animals are able to reproduce. Similar destruction of the thymus in the female produces no recognizable functional or anatomic changes in the ovary or pituitary. Control experiments prove that none of the effects seen on the testes were a pure x-ray effect, an effect of stray radiation acting directly on the testes, or a result of damage to the sympathetic plexus. The thymic effect operates through the pituitary. The fact that the reparative processes are possible indicates another important explanation for the differing experimental results reported in the literature.

These regenerative results in older animals will doubtless explain too why so little damage has resulted from roentgen treatment to the thymus. Although roentgenologists in recent years have employed an x-ray dose to the thymus which certainly does not cause any secondary changes in the testes, it is possible that the exposures during the earlier days of roentgen therapy were excessive. Even in such cases roentgenologists and pediatricians need not fear that any permanent harm was done.—*S. G. Henderson.*